DEVELOPMENT, GROWTH, AND STATE OF THE ATOMIC ENERGY INDUSTRY

HEARINGS

BEFORE THE

JOINT COMMITTEE ON ATOMIC ENERGY

CONGRESS OF THE UNITED STATES

EIGHTY-FIFTH CONGRESS

FIRST SESSION

ON

DEVELOPMENT, GROWTH, AND STATE OF THE ATOMIC ENERGY INDUSTRY

1957

PART 1

(of two parts)

Section 202, Statutory Hearings

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DEVELOPMENT, GROWTH, AND STATE OF THE ATOMIC ENERGY INDUSTRY

TUESDAY, FEBRUARY 19, 1957

CONGRESS OF THE UNITED STATES,
JOINT COMMITTEE ON ATOMIC ENERGY,
Washington, D. C.

The committee met at 10 a. m., pursuant to notice, in the Old Supreme Court Chamber of the Capitol, Hon. Carl T. Durham (chairman of the joint committee) presiding.

Present: Representatives Durham, Holifield, Price, Kilday, Dempsey, Cole, Van Zandt, Patterson, and Jenkins, and Senators Pastore, Gore, Jackson, Hickenlooper, Bricker, and Dworshak.

Also present: James T. Ramey, executive director; George E. Brown, Jr.; George Norris, Jr.; and David R. Toll, of the committee staff.

The CHAIRMAN. The Joint Committee will come to order.

The purpose of these hearings as required by section 202 of the Atomic Energy Act of 1954 is to receive "information concerning the development, growth, and state of the atomic energy industry."

It is with deep regret that we will not have Dr. von Neumann with us at these hearings. We on the joint committee admired and respected him for his qualities as a man as well as his scientific abilities and accomplishments. We will miss him very much. If there is no objection, I would like to insert in the record at this time, a statement I made on the floor of the House the other day paying our respects to him.

(The statement referred to follows:)

Mr. Speaker, it is with a deep sense of sorrow that I ask permission to address the House. On Friday, February 8, Dr. John von Neumann, Commissioner on the Atomic Energy Commission, died, after a long battle with cancer. His illness, however, did not keep him from attending important Commission meetings until close to the end. He often left the hospital in an ambulance to attend these meetings.

Dr. von Neumann was a most unusual and brilliant genius. His specialty was the most difficult kind of mathematics. He was able to devise the mathematical approach for the solution of many of the problems of the day. This mathematical approach could be used to study economic behavior, social organization, and even strategy in war. Dr. von Neumann used this mathematical ability as the key to unlock a secret in the modern concept of physics through his contributions in the development of the quantum theory, a physical theory arrived at through the use of mathematics.

But even this ability of mathematical analysis was not his only gift. For he saw the need for finding a new way of making mathematical computations and he applied his highly specialized mathematical skill to the more concrete task of creating an electronic computing machine which would perform the tedious mathematical work quickly and accurately. Because he was able to build the first electronic computer, this country was mathematically armed with a machine

capable of performing the necessary difficult calculations involved in the design of the very first hydrogen weapon.

For this work, Dr. von Neumann was awarded the first Fermi award, granted by the Atomic Energy Commission in April 1956. He was also given the Medal of Freedom by the President.

Dr. von Neumann made many appearances before the Joint Committee. While his outstanding intellectual capacity was always apparent, the members of the Joint Committee will always remember him for his humble but forthright attitude. He was indeed a genius who made many outstanding contributions to the defense of this Nation. I need not remind anyone that he came to this country in 1930 from Hungary and he lived a life symbolic of the freedoms he found here and he helped in the defense of those freedoms without thinking of personal financial gain for himself. His abilities and his genius will be sorely missed in this country in the years to come.

The CHAIRMAN. In order to provide a framework for the committee's interests in the hearings, I wrote to the AEC and about 115 representatives of industry, cooperatives, labor, and other groups extending an invitation to appear and outlining some of the particular points we are interested in.

We also issued a press release extending a general invitation to participate in these hearings. Without objection, I would like to put these letters in the record at this point.

(The letter and press release referred to follow:)

CONGRESS OF THE UNITED STATES,
JOINT COMMITTEE ON ATOMIC ENERGY,
January 17, 1957.

MR. LEWIS L. STRAUSS,
Chairman, Atomic Energy Commission,
Washington, D. C.

DEAR MR. STRAUSS: This letter is to confirm arrangements for this year's 202 hearings which have been worked out on a tentative basis by our respective staffs.

The committee is planning to hold 6 days of public hearings on February 19, 20, and 21 and February 26, 27, and 28. Exact scheduling will depend on the number of witnesses who wish to testify and on the availability of a hearing room.

It is agreed that the Commission will lead off on Tuesday, February 19, and that the industrial and other witnesses will appear on the days following. It is my understanding that you personally will make the substantive AEC presentation with a statement of about an hour's duration, summarizing the highlights of developments in the past year in the various major areas of interest, and that your chief staff advisers will be available to answer questions concerning detailed aspects of particular programs.

It is understood that there will be no other formal presentation before the committee but that more detailed statements on the major areas of interest will be made available to the committee and will be entered as an official part of the hearings record. It would be appreciated if your staff would prepare a brief cover sheet for each of the detailed statements summarizing its substantive contents.

It is understood that copies of these individual statements will be made available to the committee for its information at least 1 week in advance of the presentation and that copies of your summary statement will be made available 48 hours in advance, with the understanding that minor editorial changes could be made in the final version which you present.

In discussions with AEC representatives we have indicated the following subjects should be emphasized, in addition to the regular topics:

1. Reactor types other than for electric power, such as for process heat.
2. Fuel processing.
3. Waste disposal.
4. Price policy.
5. Dissemination of technical information to industry.
6. Program planning and scheduling of reactor projects.

The Commission's revised outline, dated December 31, 1956, appears to cover the above items, except possibly in relation to program planning and scheduling both by AEC and by private industry.

The committee is sending letters of invitation to a representative group of about 80 interested companies, organizations, and individuals to appear before the committee at the hearings or to submit statements for the record. These invitations will be sent out prior to the issuance of a public announcement which is expected to be released the evening of January 22. Copies of the letter to the invitees and the draft press release containing the public announcement are enclosed for your information.

The cooperation of your staff with the Joint Committee staff in working out preliminary arrangements on procedure and on the substance of the Commission's presentation has been excellent and is appreciated.

Sincerely yours,

CARL T. DURHAM, *Chairman.*

CONGRESS OF THE UNITED STATES,
JOINT COMMITTEE ON ATOMIC ENERGY,
January 18, 1957.

In accordance with the requirements of section 202 of the Atomic Energy Act of 1954, the Joint Committee on Atomic Energy holds public hearings during the first 60 days of each session of Congress on the development, growth, and state of the atomic-energy industry. These hearinsg provide an opportunity for representatives of industry and other interested persons to appear before the committee to present their views on the present program and laws governing that program, together with any suggested changes they believe necessary to assure maximum progress. They also provide a periodic means for keeping the Committee up to date on developments and on needs of the atomic energy industry.

This year the statutory hearings are tentatively scheduled for February 19, 20 and 21 and February 26, 27 and 28. A public announcement to this effect will be made shortly. It is presently planned to have the Atomic Energy Commission lead off the first day and to have industrial and other interested witnesses appear on the days following. The exact scheduling will depend somewhat on the availability of a hearing room and the number of persons who wish to appear.

"It is the committee's continuing intention as exemplified in the Atomic Energy Act of 1954, to encourage maximum private participation in the peacetime atomic energy program. Much has been accomplished in the past two years of which private industry and cooperative groups can well be proud. But many unique and complex problems remain to be worked out, particularly technological problems, which will require great effort, both private and government, if we are to achieve our common goals and maintain United States leadership in the development of the peaceful uses of atomic energy. As we explore new frontiers, we will inevitably encounter setbacks and problems along with successes and achievements. The Committee is the first to recognize this and is primarily concerned with assuring a program which will provide the maximum opportunity for overcoming these problems and maintaining steady progress toward our goals."

Because of your interest and experience in the atomic-energy field, I am writing to you personally to advise you of the hearings and of the opportunity to present your views, should you desire to do so. Views may be presented either in person or in a statement for the record. This letter in no way constitutes a requirement to appear, but it is the committee's hope that all who desire to be heard will take this opportunity to present their comments for the committee's information. It is hardly necessary to add that the committee needs such information if it is to discharge its responsibilities effectively.

Attached, for your guidance, is a list of subjects in which the committee is particularly interested. It is by no means a comprehensive list but indicates areas of growing importance which the committee feels may not have received sufficient attention in the past. There are, of course, other areas which you may wish to discuss in addition to the above, and all views would be welcome.

If you or one of your representatives would like to appear before the committee or submit a statement for the record, would you kindly contact the committee staff by February 8, in room F-88, the Capitol, so that the necessary arrangement may be made.

Sincerely yours,

CARL T. DURHAM, *Chairman.*

JOINT COMMITTEE ON ATOMIC ENERGY

Section 202 Hearings on the Development, Growth, and State of the Atomic Energy Industry, 1957

SUGGESTED TOPICS FOR DISCUSSION

Listed below are matters of growing importance which the Joint Committee believes may not have received sufficient attention in the past during the section 202 hearings. These subjects are in addition to the major topics usually covered and are by no means comprehensive in scope. There may well be other matters which individual witnesses will wish to discuss:

1. Reactor types other than for electric power.
2. Fuel fabrication and reprocessing.
3. Waste disposal.
4. Pricing policy.
5. Adequacy of dissemination of technical information to industry.
6. International market for reactors and components.

With respect to the civilian atomic power program, in addition to information on progress in general, and with respect to particular projects, the committee would be interested in information on technical and other problems encountered, whether initial schedules and cost estimates remain the same, and what, if any, changes are being made in them.

The proposed program of governmental indemnity against reactor hazards, and proposals for accelerating the nuclear power program, will be treated in general only and will be the subject of more detailed discussions in later hearings.

[Release No. 71 from the office of the Joint Committee on Atomic Energy, January 22, 1957]

The Joint Committee on Atomic Energy plans to hold public hearings beginning on Tuesday, February 19, to receive testimony from representatives of the Atomic Energy Commission, industry, and other interested individuals and organizations on the development, growth, and state of the atomic-energy industry, it was announced today by Representative Carl T. Durham, chairman of the committee. Section 202 of the 1954 Atomic Energy Act requires that such hearings be held during the first 60 days of each new session of Congress.

Purpose of the hearings is to provide an opportunity for representatives of industry and other interested persons to appear before the committee to present their views on the peacetime atomic-energy program and the laws governing that program, together with any suggested changes they believe necessary to assure maximum progress. The hearings also provide a means for keeping the committee up to date on developments and needs of the atomic-energy industry.

In commenting on the hearings, Representative Durham stated:

"I would like to emphasize the importance which the Joint Committee attaches to these hearings, and I hope that all who desire to be heard will take this opportunity to present their comments for the committee's information. The committee must have such information if it is to discharge its responsibilities effectively."

The hearings are tentatively scheduled for February 19, 20, and 21, and February 26, 27, and 28, depending upon the number of witnesses who wish to appear. It is presently planned to have the Atomic Energy Commission representatives lead off the first day and to have industrial and other interested witnesses appear on the days following. Those who do not wish to appear personally will be given the opportunity of presenting statements for the record. Further information may be obtained from the committee staff, room F–88, the Capitol.

This year we hoped to emphasize some new points and see some new faces, as well as the old standbys. We will see some new faces I hope. Most of the old standbys from industry have not appeared, although they have filed statements.

Let me hasten to add that I believe these hearings do some good. By focusing interest on certain questions, problems may be resolved and action encouraged. We were pleased, for example, to note that AEC has just announced a policy on fuel reprocessing—a problem which was the first item on our agenda for these hearings.

I do not think the absence of some of our industrial friends means lack of interest. Like many of us on the Joint Committee, industry may be perplexed at the situation we find ourselves in.

Some of the things which perplex us are the following:

1. Although we see steady progress in our technology, the technical and engineering problems encountered appear to be considerably greater than anticipated in many lines. This discouraging note applies to both Government-financed and privately financed projects.

The Joint Sommittee was informed last Friday that cost estimates for 2 major power-reactor projects—1 private and 1 Government financed—have increased approximately $15 million, which amounts to 20 to 40 percent of original estimates. We have been informed privately of similar cost increases on other projects. Schedules of completion on some projects have also apparently been extended, or should be extended.

2. Although the immediate financial incentives in this country for reactors does not appear good for the next few years, the need for reactors abroad is apparently very great and immediate. Thus the "three wise men" of Euratom indicated that Euratom needed 3 million kilowatts of atomic power in 1963 and 15 million by 1967.

This would mean 30 reactors the size of Detroit Edison by 1963 and 150 by 1967. This is a lot of reactors, but AEC and the State Department say the goal is feasible. I do not need to point any moral from the above.

I do hope these hearings, and those which follow it, may help to clarify and resolve these and other problems which perplex us.

Mr. Strauss, I understand that you will lead off for the Commission this morning. I want to thank you and your staff for your excellent cooperation with the Joint Committee staff in planning and preparing for the hearings, and in getting copies of your statements to the committee staff and members in sufficient time so that we could adequately review it.

Mr. Strauss, we are glad to have you with us and I understand you have a prepared statement. I believe it would be in the interests of expediting the hearings if we would first listen to your summary statement, and then question you. If it is agreeable with you, we will include in the record at the end of this day, the detailed statements submitted by the Commission.

(The detailed statements, covering major areas of interest, appear, beginning on p. 77.)

STATEMENTS OF LEWIS L. STRAUSS, CHAIRMAN; DR. W. F. LIBBY, MEMBER; THOMAS E. MURRAY, MEMBER; AND HAROLD S. VANCE, MEMBER OF THE UNITED STATES ATOMIC ENERGY COMMISSION (ACCOMPANIED BY K. E. FIELDS, GENERAL MANAGER; R. E. HOLLINGSWORTH, ASSISTANT GENERAL MANAGER FOR ADMINISTRATION; WILLIAM MITCHELL, GENERAL COUNSEL; E. J. BLOCH, DIRECTOR, DIVISION OF PRODUCTION; H. N. ESKILDSON, CHIEF OF ADMINISTRATION (ACTING), DIVISION OF PRODUCTION; W. KENNETH DAVIS, DIRECTOR, DIVISION OF REACTOR DEVELOPMENT; DR. C. L. DUNHAM, DIRECTOR, DIVISION OF BIOLOGY AND MEDICINE; JOHN A. HALL, DIRECTOR, DIVISION OF INTERNATIONAL AFFAIRS; JESSE C. JOHNSON, DIRECTOR, DIVISION OF RAW MATERIALS; DR. T. H. JOHNSON, DIRECTOR, DIVISION OF RESEARCH; C. L. MARSHALL, DIRECTOR, DIVISION OF CLASSIFICATION; D. F. MUSSER, DIRECTOR, DIVISION OF NUCLEAR MATERIALS MANAGEMENT; C. A. NELSON, DIRECTOR, DIVISION OF INSPECTION; H. L. PRICE, DIRECTOR, DIVISION OF CIVILIAN APPLICATION; MORSE SALISBURY, DIRECTOR, DIVISION OF INFORMATION SERVICE; OSCAR S. SMITH, DIRECTOR, DIVISION OF ORGANIZATION AND PERSONNEL; DON S. BURROWS, CONTROLLER, DIVISION OF FINANCE; A. TAMMARO, ASSISTANT GENERAL MANAGER FOR RESEARCH AND INDUSTRIAL DEVELOPMENT; BRYAN F. LaPLANTE, SPECIAL ASSISTANT TO THE GENERAL MANAGER)

Mr. STRAUSS. Thank you, Mr. Chairman. I should like to begin this statement by recording the great loss which we of the Commission have sustained through the death of our well-loved colleague, Dr. John von Neumann, on February 8, after a long and cruel illness.

At our first meeting following his death, we adopted a resolution expressive of our grief. In view, Mr. Chairman, of your inclusion in the record of your remarks in the Congress on the same occasion, I would like to request that this resolution by the Commission be included as a part of the record this morning.

The CHAIRMAN. Without objection, it is so included.

(The resolution is as follows:)

A RESOLUTION BY THE ATOMIC ENERGY COMMISSION

With a profound realization of the loss that we have suffered in the death of our well-loved colleague, John von Neumann, we meet today in sorrowful recognition of the irreplaceability of his talents and of the tragedy to us as individuals, to the Commission, and to the Nation.

A man blessed with extraordinary intellectual gifts, preeminent in his generation in the sciences, the value of his contributions to the work of this Commission is truly incalculable. His disciplined mind simplified the most difficult problems and enabled wise decisions to be reached. His human qualities, personal charm, his warmth, sense of humor and his wide sympathy endeared him to every member of the organization, and the particular place he made for himself in our affections cannot be filled.

To his widow and the members of his family whose grief and affliction we share, we, his colleagues, extend our heartfelt sympathy.

Mr. STRAUSS. It has been a rewarding experience for the Commission and the members of the Commission's staff—in accordance with the requirements of section 202 of the Atomic Energy Act—to review the growth of the atomic energy industry during the past year. On a subsequent occasion I hope you will afford me an opportunity in executive session to testify on weapons development, and to deal with several misapprehensions which are now on the record.

All of us, of course, who have been associated with the day-by-day developments in the atom's industrial expansion, have watched with increasing satisfaction the steadily mounting peaceful uses of nuclear energy in the 12-month period. The detailed record is, we believe, an impressive account of the world leadership to which our scientists, engineers, and American industry have jointly contributed to develop nuclear energy for defense and for peaceful progress.

In the interest of avoiding repetitive testimony—and with respect for the demands upon the time of your committee—we will here provide a concise résumé of the detailed written testimony which has been in your hands for the past several days.

Since you have been kind enough, Mr. Chairman, to say some pleasant things about our staff, I should like to reciprocate with respects to your own staff. We have had the best of cooperation from the staff of the Joint Committee.

No summary can anticipate and identify all of the points of specific interest to your committee. The project is, as you know, very large and very complex. Therefore, at the conclusion of these summary remarks my colleagues and I will try to answer your questions and amplify any of the portions of my statement or the prepared material already submitted to you.

My colleagues on the Commission, Dr. Libby, Mr. Vance, and Mr. Murray; our General Manager, General Fields; and the directors of the staff divisions concerned are here to furnish further information as your interest may develop.

Since the Commission reported to you a year ago, pursuant to section 202 of the act, the progress which has been made in developing an atomic-energy industry free of Government monopoly has embraced additional areas of work and a large number of projects.

The Commission, for its part, has continued to develop basic technology and to provide both the necessary supplies and the services contributing to the sound growth of such an industry. Not only have private investors been able to move forward in supplying materials and services at home and abroad, but their long-range planning has been facilitated by definitive pricing and other policies.

The Commission, in its role of partner in this development, has adhered to the mandate given to it by the Congress in the 1954 act—that is to say, the requirements that the development, use, and control of atomic energy shall be directed so as "to strengthen free competition in private enterprise."

When your committee received testimony at the first of these hearings in early 1955, the atomic-energy industry was but a few months removed from its original status of a Government monopoly.

Today, in the space of only 2 years, the forces of traditional American free enterprise may be seen moving forward on a broad front. They already have to their credit numerous solid accomplishments,

resulting from the application of competitive cost-reducing incentives to the new nuclear technology.

During much of this 2-year period, industry has been familiarizing itself with the technology opened to it by our "access program" and the comprehensive declassification of nonweapon technical data which we have brought about. Industry also has embarked upon a period of building up research and development facilities and acquiring teams of scientists and engineers to operate those facilities.

The latter requirement has not been an easy one for industry to meet, and in this era of rapidly expanding technological activity and an apparent shortage of technical manpower in all branches of science and industry this difficulty has been accentuated.

Particularly noteworthy has been the progress achieved during the past year in those sections of the atomic-energy industry engaged in the development, construction, and operation of power-producing nuclear reactors. The construction of privately built and privately operated plants for critical experiments, materials testing, and for the fabrication of fuel elements already is well underway.

Concerns which supply such essential reactor materials as graphite, boron, zirconium, and special alloys are rapidly learning the special requirements of the atomic-energy industry. This is true also of the firms which manufacture instruments, controls, and other components for reactors.

As regards companies doing the actual construction of reactors, at least 21 different American firms are either presently building, or have orders to build, civilian research or power reactors.

As the members of your committee know, electric power from nuclear fission is now provided for all the facilities of the great Argonne Laboratory from the boiling-water reactor which formally began operation there on February 9, an event which, I am happy to say, was attended by the chairman and several members of the Joint Committee.

The boiling-water reactor thus became the first harvest of the Commission's experimental power program inaugurated 3 years ago to test the feasibility of different types of civilian-power reactors.

Before the current calendar year is ended, 5—and perhaps 6—reactors, including the boiling-water reactor, will be delivering electrical power in the United States at various points from coast to coast. Four of these 6 projects were launched under the Commission's experimental-power program, the largest being the full-scale, central-station Duquesne-Westinghouse atomic powerplant at Shippingport, Pa., with its capacity of 60,000 to 100,000 electric kilowatts, the world's first such plant devoted entirely to serving civilian needs.

Before the Shippingport plant opens, commercially distributed power is scheduled to flow from the sodium reactor built for the Commission by North American Aviation at Santa Susana, Calif., and also from General Electric's prototype powerplant at Vallecitos, Calif.

The Army package powerplant at Fort Belvoir, Va., built by a subsidiary of the American Locomotive Co., will be delivering electricity into the post's power system this spring. I believe that will be in April.

The homogeneous-reactor experiment at Oak Ridge, although having encountered technical difficulties in its nonnuclear system, is expected to come into operation this year and supply electric power to the great laboratory complex there.

All in all, as summed up, not in the Commission's testimony, but in industry's own published reports, the United States atomic industry in 1956 began construction or received contracts on a total of 59 new nuclear reactors, including 29 power-producing reactors and 30 research and test reactors.

The research and test reactors will be built for private United States buyers, for the Government, and for overseas export. The power-type reactors are designed for various needs as, for example, naval and merchant-ship propulsion, for prototype and demonstration reactors for the Atomic Energy Commission, and for land-based power demonstration plants for private purchasers.

In addition to these projects, industry reports that it has carried forward work on contracts awarded prior to 1956 for 17 reactors of various types, and that it has completed construction of 2 reactors which had been on order. I would like to say here, Mr. Chairman, that since this report was prepared, we have received indication of 3 new civilian power projects, 2 of them of considerable size.

Still referring to reports from industry, as compiled recently, it is interesting to note that during the past year American firms signed contracts or announced plans for 9 uranium ore processing mills, a feed materials plant, 5 nuclear fuel element manufacturing plants, 7 critical facilities and 3 zirconium and 2 beryllium production facilities.

All of this has been realized since the new act of 1954 freed American industrial incentive.

Looking ahead to continued and accelerated progress in the current year, there have been published estimates gathered directly from industry that about $270 million may be spent in 1957 on the construction of civilian power and military reactors, that uranium mining and milling may account to another $200 million, the manufacture of instruments to about $33 million and industrial nuclear research activities—separate from power reactors—to about $25 million, for a total in excess of a half billion dollars of private capital.

It has been stated in one independent survey of the situation that, in dollar volume, the atomic reactor business of American industry, has been trebled during 1956.

Progress has been most encouraging and I believe the Joint Committee and the Congress can take justifiable pride in having opened the way to such rapid development of an independent atomic energy industry in this country. Both the Commission and industry look with confidence to the Congress, and particularly to the Joint Committee, to provide the necessary new legislation to insure further growth and progress.

In this connection, it is gratifying to note that legislation originating with members of this committee has again been presented to the Congress to provide the more complete third-party insurance protection which is so essential to the Nation's pioneering ventures in atomic power development.

I turn now to the highlights of achievements during the past year in each of the nine general areas of atomic industrial development. These areas, as we have listed them as they are more fully delineated in the written testimony before you, cover the following:

The industrial use of radioisotopes, raw materials, information for industry, industry's manpower base, supplying the atomic energy

industry, some aspects of Government policy affecting atomic energy industrial development, progress in reactor development, licensing and regulation of industry, and United States industry in the atoms for peace program.

I shall deal with these topics briefly in the order I have just listed them, the first being the industrial use of radioisotopes.

ISOTOPES IN INDUSTRY

American industry, medicine, and agriculture are benefiting from the use of radioisotopes, which represent the first peaceful dividend from our national investment in atomic energy. The benefits in medicine cannot, of course, be appraised in terms of dollars; they are the priceless data of more knowledge of the body and its functioning, more accurate and earlier diagnosis of human ills, and the increasingly effective treatment of those ills.

Different estimates place the number of patients being diagnosed or treated with radioisotopes at between 800,000 and 1 million persons each year. The gains to clinical research as well as to the patients and their physicians are incalculable. The results in the alleviation of human suffering are beyond price.

Isotopes have brought to the hand of agricultural scientists tools which enable them to accomplish studies never before possible. These studies bring forth better crop varieties, more effective fertilization, improved control of crop and livestock pests. As the results of these studies are applied and put to use on the land, large economic benefits are realized.

Estimates have been made that the potential savings from use of radioisotopes in agricultural research and practice will exceed $200 million annually. It is my belief that this amount will greatly increase with the years.

In industry it is possible to make closer estimates of dollar savings from the use of radioisotopes. The Commission recently has undertaken to arrive at such estimates, after interviewing more than 40 firms making use of radioisotopes and receiving written information from more than 100 others.

As reported more fully in section II of the detailed reports, the survey indicates a savings of at least $295 million a year and perhaps as much as $485 million. The average is $390 million—more than a third of a billion dollars of savings resulting from industrial use of radioisotopes—a "byproduct" of our nuclear power program.

The rate of growth is rapid, and it may well develop that the savings to industry alone, not including the benefits in medicine and agriculture, will in a few years repay the Nation handsomely for its entire investment in atomic energy development.

Today's major industrial applications of radioisotopes embrace many fields of technology, industrial research, thickness and density gaging, industrial radiography, and applied industrial tracing, to mention only a few of the major ones.

Looking ahead, the trend seems to be toward additional uses such as strong sources for radiation in the food, drug, chemical and other industries and more novel applications of tracers in a growing variety of industrial processes.

As the applications multiply, it is natural that private enterprise should enter into the field of processing and distribution of radioisotopes. Nearly 100 private firms are in these fields now, a sixfold growth in 5 years. Several times this number provide accessory equipment and services.

Industry's inventiveness and management are being brought into use to provide the implements and machines required for the use of high energy sources of radiation, as well as instruments for measuring radiation. Such devices are indispensable to the new techniques of research, production and healing made possible by radioisotopes. It is estimated that for cobalt 60 therapy alone, there will be by 1966 a prospective market for 4,000 machines used in application of that radiation, each to sell at between $20,000 and $70,000.

The development of an industry for radiation detection instruments is one of the bright prospects of the new nuclear age. The Commission has encouraged this industry, particularly by looking to it to supply the standard instruments and those newly developed either by industry or by Commission research.

Later this morning I hope that you will permit Dr. Libby, to whom this subject has been of great interest, to give you some further information on this subject which I think is exciting and inspiring.

RAW MATERIALS BASE FOR THE INDUSTRY

The atomic energy industry is founded on the firm base of a supply of uranium ample to meet the requirements of both our civilian and military atomic programs. This Nation has become the leading uranium producer of the free world. Nine years ago 90 percent of the United States uranium supply came from overseas. Today 60 percent originates in North America and by 1958, approximately 80 percent of a much larger supply will be provided from this continent. By adding increased deliveries from south Africa and continuing production from the Belgian Congo, Australia, and Portugal, we have assurance of supplies to meet all our present requirements.

Precise information regarding current and prospective uranium supplies has become necessary to enable the uranium industry to plan for its future. Accordingly, in the broad declassification action of last December, this Government joined with Canada and the United Kingdom in removing such information from its secret status in which it had been previously held.

As a further assistance to the industry, the Commission established a new uranium procurement program which provides a domestic market from 1962 through 1966 for uranium concentrates.

The past year saw both substantial addition to the known domestic ore reserves and sharp advances in mine and mill output. Within the next 3 years we expect ore production and mill output of concentrates nearly to double. All the mines and all but one of the mills are privately financed and privately operated.

INFORMATION BASE FOR THE INDUSTRY

Along with the access to raw materials, knowledge of the technology of atomic energy applications is basic to the growth and development of an atomic energy industry. The committee is, I am sure, familiar

with the successive steps taken by the Commission to enlarge the flow of information developed in the Government's atomic energy program.

In 1955, we adopted policies providing for a wide declassification and downgrading of information to bring it within the reach of science and industry. In December 1956, just 2 months ago, another broad declassification policy was adopted which further widened the area of open technology useful in civilian application.

This policy is being applied presently by means of an expedited declassification operation carried on by teams of experts in various technical lines working as a group at Oak Ridge.

When this operation is completed, the technical information required by the atomic energy industry—from uranium mining to chemical processing of spent reactor fuels—will, in the main, be freely available in open literature. Of course, there will remain some items of technology which must continue to be classified for national security considerations. Such classified data will be available through the access permit program to industrialists having need for it.

The number of holders of access permits almost doubled in the past year, and the sales of classified reports increased in proportion. Sales of printed unclassified reports increased by more than half and sales of microcopies of these reports was fourfold greater than the year before. Access permits continue to be sought and granted, though at a declining rate as more technology becomes unclassified and as more of those interested in the new atomic energy industry already have obtained access permits.

Today the atomic energy industry can rely upon an information service of unprecedented scope and variety. The service includes not only Government issuances, but a rapidly growing volume of publication in the journals of the engineering societies, the technical and business press, and the books of technical publishers. We look for such services to expand rapidly as more unclassified information emerges for use by the publishing industry.

The Commission is summarizing nearly 100 fields of data in single books so that industrial firms, and especially small firms, will not be compelled to search the entire literature which has become voluminous.

The Commission will endeavor further to help industry keep up to date on new science and technology through a system of current progress reviews in various fields.

Technical meetings for industry have been held with increasing frequency in connection with the programs for encouraging private investment in special lines of service and supply. Some of the meetings are for access permit holders only, and are held on a classified basis. Others are open and on an unclassified basis.

MANPOWER BASE FOR THE INDUSTRY

The third fundamental basis for a sound and progressive atomic energy industry and no less crucial than raw material and information is trained manpower. The Joint Committee has shared the concern of the Commission and, indeed, of the whole community of education, science and industry over the existing shortage of engineering and science graduates.

Imposed upon the general shortage of manpower is the additional problem for the atomic energy industry of developing the special competence required in its particular field. To determine the extent and character of this particular shortage, the Commission has undertaken comprehensive surveys. Industry is conducting training programs and the Commission's contractors reported 14,000 trained in special courses in the past calendar year. Meantime, to help toward alleviating the shortage, the Commission has continued to expand its own educational and training programs which include special graduate schools, fellowship programs, and college faculty training programs.

Assistance to colleges and universities in the way of teaching aids and training equipment is being extended. Three new programs have been initiated for training high-school teachers in nuclear science and technology, it being our considered opinion that the root of this trouble lies in the seconday schools of the country.

SUPPLYING A DEVELOPING INDUSTRY

As I mentioned earlier, there has been a large increase of private investment in the business of supplying and servicing the new atomic energy industry, and the Commission is encouraging this activity in every feasible manner. However, in making the transition from a Government monopoly to industrial activity, there are areas in which the Commission has had to take some initiative to assure a well-rounded industrial base.

Most of these involve situations in which the present demand for the product or service is largely by the Commission, but where industrial demands are now beginning to accumulate.

The problem is to supply the commercial demands either by the creation of industrial capacity or, if necessary, by using Commission facilities and, in the latter case, to do it in a way which will not discourage eventual provision of the product or service by private industry.

During 1956, the Commission entered into a contract with the Allied Chemical & Dye Corp. to deliver uranium hexafluoride to the AEC at a rate equivalent to 5,000 tons of U_3O_8 annually over a 5-year period.

Another private firm, the Mallinckrodt Chemical Works, has provided facilities for converting uranium hexafluoride to forms in which it can be used for reactor fuel elements. There are a sufficient number of companies now ready to fabricate the fuel elements themselves so that the Commission now has withdrawn almost completely from fabricating fuel elements for private projects. In fact, we are now obtaining some of our own fuel fabrication requirements from private commercial suppliers.

Thus it will be seen that capacity already exists or firm plans have been established to process uranium ores into many of the forms of uranium needed for fuel-element fabrication or into the form required as feed for gaseous diffusion plants.

Industry also is preparing to process enriched uranium hexafluoride removed from a gaseous diffusion plant into many of the forms required for fuel-element fabrication and to fabricate the fuel elements themselves.

Last year we mentioned plants to encourage industry to establish facilities for chemically processing the spent fuel elements of reactors. The Commission has furnished interested firms a list of types and quantities of Government-controlled fuels which might be made available for processing under contract.

It is to be hoped that, by contracting for separation of these fuels, the Commission can help to establish a base load sufficient for operation of an industrial plant during the early period when fuels from privately operated reactors alone would not be sufficient to sustain such operations.

However, because of the present state of technology and the indeterminate nature of the total loads during the next few years, firm plans have not yet emerged for an industrially owned facility to provide power reactor operators with the assurance that their irradiated fuels could be processed at reasonable charges.

In order that power reactor development, construction, and operation may be relieved of this major uncertainty, the Commission has decided to provide such assurance for the time being. As we recently advised the committee, we are offering to enter into contracts with licensed reactor operators to provide for processing of their spent reactor fuels through June 30, 1967, at fixed prices subject only to escalation on the basis of a recognized price index.

All such contracts will be subject to cancellation by the Commission upon 12 months' notice if and when it finds that the required processing services will be available commercially at reasonable prices.

SOME ASPECTS OF GOVERNMENT POLICY AFFECTING THE INDUSTRY'S DEVELOPMENT

Various actions taken by the Commission in 1956 further expedited nuclear development. These included the declassification of the charges for uranium 235 as reactor fuel and prices to be paid for special nuclear materials produced in reactors abroad and at home, fueled by uranium allocated by the United States Government.

In line with its authority to establish guaranteed fair prices to be paid over a 7-year period for special nuclear materials produced by licensees, the Commission in November 1956 established prices to be paid for plutonium and uranium 233 during the year ending June 30, 1963.

The Commission also stands ready to buy plutonium and uranium 233 produced in foreign reactors fueled with material furnished by the United States, but such purchases presently depend, of course, on annual appropriations by the Congress.

Patent applications relating to atomic energy filed in 1956 by United States industry totaled approximately 450, as against about 135 in 1955 and 50 in 1954. That, it seems to me, is an eloquent indication of the increasing interest and activity of industry since the passage of the Atomic Energy Act of 1954.

In September 1956 the Governments of the United States, the United Kingdom, and Canada concluded an agreement interchanging rights in inventions and discoveries made during the period when atomic energy operations were largely a Government monopoly.

The power bilateral agreements concluded with six countries giving this country rights in inventions resulting from interchange of classified information.

PROGRESS IN NUCLEAR REACTOR DEVELOPMENT

I come now to the status of American industry in the development of electrical power from nuclear fission. Along with the benefits from the radioisotopes, which I have already summarized, this represents as of now the major economic promise of the peaceful atom.

In this segment of the Nation's atomic enterprise there are many participants, including industrial suppliers of materials and services, builders of reactors, contractors and hundreds of subcontractors, the Commission's own expanding programs for the development of basic reactor technology and the research and development assistance extended to the power projects undertaken without dependence on direct Government financial contribution.

In this summary, I will refer only to the highlights of the past year and the plans underway for the future in the nuclear power and other reactor projects in the United States. Greater detail will be found in the prepared testimony already handed to your committee. That testimony will be amended by the inclusion of the new proposals to which I referred a few moments ago, and which were received subsequent to the preparation of this statement.

At the beginning of 1957, a score of firms were known to be constructing or to have orders to construct civilian power or research reactors. Thus it will be recognized that the development of commercial industrial competence in the civilian reactor field is well on its way.

As to power reactors, it is significant that as 1957 opens there are underway, in various stages of construction, discussion or negotiation plans for at least 19 civilian nuclear powerplants in the United States to come into operation not later than 1962.

These projects include the 17 listed as of January 2, 1957, at pages 54 and 55 of section VIII of the written testimony and the project announced by Northern States Power Co. on February 8. These plants will represent an investment of some $700 million, with a large proportion of that sum to be supplied by industry itself.

The projects are in various stages, some having only recently been announced by newly formed private groups. The total kilowatt output of these plants is not, in my opinion, of paramount significance. Of much greater importance is the fact that these projects represent a number of different types of reactors and that, from experience with them, will emerge the knowledge which will decide the technology best fitted to the economics of different conditions of location and supply of competitive fuels not only here but in other parts of the free world.

Mr. Chairman, we have brought with us this morning—if time permits and your interest runs so far—a series of large photographs of those plants which are under construction. Some of them, I assume, the committee has not visited and they may be of interest to you.

The CHAIRMAN. We will be glad to see them.

Mr. STRAUSS. A word should be added at this point about the contributions of our military reactors to the civilian reactor development. Nearly three-fifths of the Commission's expenditures for reactor development are presently assigned to the deveolpment of military reactors, primarily for propulsion.

In many ways these activities are of indispensable benefit to peacetime development. More and more nonmilitary data resulting from them are being declassified and made available to the reactor industry.

Several Government actions of 1956 and 1957 were pointed toward speeding the progress of civilian power-reactor development. Highly important were the President's action of February 22, 1956, in making available 40,000 kilograms of uranium 235 for reactor fuel at home and abroad; and the Commission's action of last November declassifying the charges to be made for enriched fuel and the prices to be paid for special nuclear materials of fuel value produced in the reactors here and overseas which are fueled with United States uranium.

Another step toward expanding civilian power development was taken early this year by the Commission when it issued a third invitation to industry to submit proposals under the power-reactor demonstration program which was inaugurated 2 years ago.

In this new invitation, the Commission placed no limitation on the types or sizes of plants which may be proposed except that they should make significant contributions toward the achievement of commercial utilization of nuclear power and that construction of the plants should be completed by June 30, 1962.

In general, the Commission wishes to consider any practical proposals which will advance the time when nuclear power will become economically competitive.

The Commission especially desires, as it stated in its announcement, to encourage large-scale powers-demonstration projects using reactors fueled by natural uranium and moderated by heavy water and reactors fueled by aqueous solutions or slurries of uranium or of uranium- and thorium-bearing materials for breeding purposes.

Other types of power reactors will be specified for research and development support by the Commission as technological progress appears to warrant. We have provided additional details of this undertaking on pages 22 and 23 of section VIII of the detailed testimony dealing with reactor progress furnished to the committee, and I will not repeat them here.

The Commission in its announcement stated that if industry does not submit acceptable proposals for reactor plants of the types considered ready for full-scale demonstration and construction, the Commission will request funds to initiate such projects under complete Federal financing. This statement, as you will recall, was also included in my testimony before your committee in May of 1956.

In our semiannual reports and in the detailed written material prepared for these hearings, we have set forth the status of the Commission's program for developing reactor technology through the Commission's experimental reactor program begun in 1954, and under the first two invitations in the power demonstration reactor program. One project (the EBWR) in the experimental program already has come on line this year, 3 or perhaps 4 others will begin operation later in the year, and construction of a fifth will start.

In addition to its 5 original concepts, the program now includes 5 other concepts and a total of 13 reactor projects and 2 study programs, one looking eventually toward reactor projects using natural uranium as fuel and heavy water as moderator and another using plutonium as fuel.

Industry and the Commission are working on arrangements for cooperation in 7 nuclear power projects as a result of the first 2 invitations under the power reactor demonstration program.

Reactors offer promise of a number of industrial uses in addition to the production of power and the Commission and industry are experimenting to develop the technology of these other uses. The written testimony reports in detail on the status of projects to employ reactors as sources of industrial process heat, for propulsion of merchant ships, locomotives, and overland cargo carriers, for isotope production, and for irradiation preservation of foods.

As a further indication of the scope of the Commission's activities in the development of civilian nuclear power, we might point out that expenditures for this purposes proposed in the 1958 budget now before the Congress stand at $135 million as compared with $85 million in the present fiscal year, $51 million in fiscal year 1956, and $28 million in fiscal year 1955.

Thus, the activities of Government in the development of efficient, economic and safe nuclear power will in 1958—provided, of course, that Congress approves our requests—represent a fourfold dollar increase over 3 years ago.

An important part of the development of reactor technoloky is directed toward solving the problems of reactor safety. The Commission is ever mindful of the important factor of operational safety in the development of commercial atomic powerplants, and is determined that no nuclear powerplant will be licensed for operation anywhere in the United States until and unless it conforms to the stringent safety requirements established by the Commission.

Allied with this subject of reactor safeguards is that of the disposal of waste products. The eventual cost of safely disposing of these ashes from nuclear furnaces is an important, and as yet largely undertermined, factor in calculating the economics of nuclear power production.

However, the Commission has steadily increased its research into the basic questions involved in waste disposal and the engineering problems which must be solved in connection therewith.

I should like to make brief reference at this point to the matter of our expended research in the challenging field of controlled thermonuclear reactions. To interject a personal note, I might say this was my first item of concern when I returned to the Commission in 1953.

All of this work is, of course, still in the basic research stage. Many problems remain to be solved, as the members of your committee are well aware, and years, perhaps, of intensive effort lie ahead before we will have a prototype thermonuclear device yielding more energy than is required to operate it. After that, still more years probably will be required to achieve a full-scale device economically competitive with other sources of power.

In our intensified research on Project Sherwood, as the controlled thermonuclear research is known, the Commission is keeping industry informed of the status of the work.

In order that industrial firms entering upon the development of nuclear power from fission may have an opportunity to assess the prospects of ultimate competition from the fusion reaction, the Commission on February of last year to that end authorized the issuance of access permits for controlled thermonuclear information under precise conditions.

Before concluding this section on nuclear reactor development I should note that Commissioner Murray will submit a separate statement of this topic. He has specific objections to section VIII of the Commission testimony, which deals with reactor programs, but those specific objections are not yet known to the Commission.

LICENSING AND REGULATION OF INDUSTRY

The number and variety of licenses applied for and issued by the Commission during 1956 represent an accurate gage of the growing private participation in the atomic energy field. The detailed record of applications and issuances is given in the written testimony.

Basic to the entire licensing process is a most prudent evaluation of the safety aspects of proposed reactors and other nuclear facilities. The Commission assembled during 1956 a technical staff of physicists and engineers to perform this function, with the aid of other specialists within the Commission.

The safety control of some 50 Government and privately operated research and power reactors and critical assemblies thus far have been reviewed and evaluated.

The substantial expenditure of technical talent and effort by license applicants demonstrates that American industry, which is highly safety conscious, has accepted its responsibilities in this respect. The Commission has undertaken a comprehensive study of the potential damage which might result from the nuclear runaway of a power reactor.

At the beginning of 1957 the basic framework for the licensing of private atomic energy activities is virtually complete. No major difficulties with the regulations have been reported, but experience is suggesting various beneficial changes and we anticipate that further experience will lead to additional revisions.

The Commission also has enlarged its efforts to work closely with State agencies in the licensing program. Appropriate State agencies are notified of all licensing actions. Two meetings of the Commission's Advisory Committee of State Officials were held last year. State regulatory agencies have been encouraged to participate with Commission staff members in inspection of licensees.

In the field of regulation, the Commission believes that all possible effort should be made to achieve a maximum degree of uniformity between the Commission on one hand and the several States on the other.

UNITED STATES INDUSTRY IN THE ATOMS-FOR-PEACE PROGRAM

The design, development and construction of reactors, components and materials by United States industry is an important element in promoting the United States atoms-for-peace program which is making steady and promising progress toward the goals set forth by

President Eisenhower in his pronouncement of December 8, 1953, calling for worldwide cooperation in the use of fissionable material for peaceful purposes.

Fifteen research reactors have been contracted for or are being discussed with United States industry by foreign countries, and American firms are providing the principal design details on seven nuclear power projects currently under consideration by other nations.

Details of these will be found in the appropriate section of the material provided you. A number of additional countries are known to be in contact with United States firms and consultants on projects for the development of nuclear research and power programs in those nations.

During 1956, 16 new bilateral agreements were negotiated, bringing the total to 43 agreements with 41 nations. The most significant development was the concluding of nuclear power agreements with Australia, the Netherlands, Switzerland, France, and Norway. Almost all parts of the free world are now represented in the United States bilateral program. Negotiations are currently in progress with 21 nations; 10 of these do not at present have agreements; 11 are looking toward additional research or power bilaterals.

The significant Government actions during 1956 which have facilitated the progress of peaceful uses abroad have included making enriched uranium fuel for power and research reactors available to friendly countries on favorable terms, establishing the means of rendering financial assistance through direct matching grants for research reactor projects and through Export-Import Bank loans for both research and power reactor projects, adoption of a revised declassification guide that will make more technical data available, and enlarging the facilities for training of foreign nationals in this country in basic reactor technology.

United States industry also is being encouraged to produce more types of equipment and provide a greater range of services in the atomic energy field, thus generally increasing its ability to participate in a competitive export trade. Efforts have been made to simplify rules and regulations so as to permit freer contacts between private commercial parties of the United States and the nations with which we have bilateral agreements.

The Commission's power-reactor development program is directly applicable to the needs of foreign countries through emphasis on development of reactors in the small-size ranges. American technical missions have visited a number of foreign nations to advise on basic planning, and some 700 foreign nationals, including many scientists, engineers, industrialists and political leaders, have come to the United States to consult with the Commission and its expert staff and with private industrial representatives concerning their atomic-power programs.

Further impetus was given to this country's program of international cooperation during 1956 when procedures were simplified for the export of both radioactive and stable isotopes. These nuclear products are now available to foreign countries on a routine basis, from the Commission's own laboratories and from more than 75 American firms.

The course in radioisotope trace technique at the Oak Ridge Institute of Nuclear Studies gave training to 39 persons from other

friendly countries during 1956 and this program is being continued and expanded.

Important regional atomic groups are developing in Europe and Asia. In Latin America, we look for significant results, particularly in the training of nuclear scientists, engineers and technicians. This will occur from centers being established with Commission cooperation at the University of Puerto Rico, at the Inter-American Agricultural Research Center at Turrialba, Costa Rica, and from the program which is being established under the aegis of the Organization of American States.

Three weeks ago I had the gratifying experience of participating, in the company of Commission staff representatives and officials of the Oak Ridge Institute of Nuclear Studies, in a symposium on the peaceful uses of atomic energy at the University of Puerto Rico.

Finally and most importantly in the field of international cooperation, I come to the action taken in 1956 to bring nearer to fulfillment President Eisenhower's historic proposal to strip the atom of its military casing in order that "the miraculous inventiveness of man shall not be dedicated to his death, but consecrated to his life."

Last October 26, some 80 nations of the world, gathered at the United Nations in New York, adopted without dissenting vote the charter of the International Atomic Energy Agency first proposed by the President in 1953.

The President, in his state of the Union message to the Congress last month, spoke of this country's opportunity, within the International Agency, to "demonstrate once again our unalterable purpose to make of the atom a peaceful servant of humanity," and stated that he would shortly ask the Congress to authorize this country's full participation in the Agency.

This concludes my summarizing statement. I have sought to deal only with the highlights of the material contained in the written testimony already submitted to you. Even so, I fear that my remarks have been much too extended and that undoubtedly I have neglected to touch upon some items of our activities which are of particular interest to you and to other members of the committee. I am sure that you will wish to afford my colleagues on the Commission who are here, an opportunity to make individual comment.

As I noted at the outset of my statement, the members of the Commission, General Fields and heads of the Commission's staff divisions concerned with the industrial development of atomic energy are present and at your service.

Thank you very much.

The CHAIRMAN. Thank you very much, Admiral Strauss. You have given to the committee, and to the country at large, a very bright picture of the industry and I expect there will be many questions by members of the committee that will be asked.

I believe the committee, too, can agree with you as to the contribution made by the military participation in this program. I have reference to Admiral Rickover's development of the nuclear-powered submarine and also the package power reactor at Fort Belvoir, which several members visited last week, and also the aircraft nuclear power development which has made some progress. But some members of the committee do have concern about the aircraft nuclear-propulsion program.

One of the things that has been complained about by industry all through this process has been declassification of more information. At the present time we have almost complete declassified reactors.

For instance, if we declassify everything on Shippingport, is that information available to every individual that comes in and asks for it?

Mr. STRAUSS. My belief, Mr. Chairman, is that all essential information with respect to pressurized water reactors is in the public domain. Obviously the reactor on the *Nautilus*, which is a pressurized water reactor, has certain features that are peculiar to the use to which it is put and these features must for the foreseeable future remain classified. But as far as the Shippingport reactor is concerned, that is not the case. As a matter of fact, large numbers of uncleared visitors, including foreigners, have visited Shippingport.

The CHAIRMAN. I had reference to power-producing reactors such as Shippingport. The interest is not so much in the military reactors. In view of the declassification of all this information, why is it necessary now to continue the access permits?

Mr. STRAUSS. For this reason, Mr. Chairman: There are areas of classified military information, where on a preferred basis—preferred in the sense of need to know—a cleared industrial firm can afford the Commission assistance as well as benefiting their own work.

I might comment, sir, on one of your introductory remarks, if I understood you correctly. We have heard no specific complaints from industry with respect to our classification program. I should be more specific and say I have had no industrialist say to me that there was any information that he needed that he could not obtain. I believe that is a statement that would apply to the Commission. Could the General Manager confirm that fact?

Mr. FIELDS. I have had no statements in the last 6 months to this effect that have come to my attention.

The CHAIRMAN. It was in the beginning.

Mr. FIELDS. In the beginning there were some complaints; yes, sir; but the recent action will entail declassification of all civilian power reactor information except such information as might be unique for military reactors, as well as civilian reactors. There is some information of this nature that would indicate a continuance of the access permit program was desirable.

Mr. STRAUSS. The committee is certainly aware, Mr. Chairman, of the very large amount of material which has been declassified or downgraded in the last 3 years, and of the overriding necessity to review every such item with extreme care in order to see that there is no regret after its declassification, that material has been released that should not have been released. It cannot be recaptured. For that reason each piece or category of information must be evaluated before it is released. The Commission is particularly sensitive to its great responsibilities in this connection.

Mr. FIELDS. In order that my answer is complete, could I make one more statement, sir?

I have had discussions—complaints, you might call them—that the amount of information is so large, there is so much of it, that it is not in a readily assimilable form. That is one of the reasons why we have a very extensive writing program and are encouraging industrial

technical journals to do a lot of writing themselves. This is one of the reasons for this program. There is so much that it is hard to get hold of it.

The CHAIRMAN. I have been especially gratified with some of the declassification of this material in order to get along with the program.

We will try to take the questioning from individual members one at a time. Senator Pastore?

Senator PASTORE. Thank you, Mr. Chairman. I only desire to ask a question or two on one phase of the report. I have a meeting in my office at 11:15 and then I shall return.

Referring to pages 31 and 32 of the statement on this International Agency, I take it from the way you have presented it in your report that you are very much in favor of the draft statute that was approved at the United Nations this last fall?

Mr. STRAUSS. Senator, I am. Like any other document, I feel that it could be improved. I could improve practically any letter I write, after I had an opportunity to review it over a period of months. This was the best document that could be prepared by 80 nations in a conference in which a very competent team represented the United States. I am for it, and I have great hopes for the future from it.

Senator PASTORE. I should like to say to the distinguished Chairman of the Commission that I am for it, too. This is my question: Why has not it come to the Congress yet?

Mr. STRAUSS. I am unable to answer that, Senator. From the time that it was approved, or signed, or initialed by the representatives of the 80 nations, including our own Ambassador Wadsworth, and through the period of the President's message, the matter has been in the State Department. I am unable to say anything about the time schedule of its coming before the Senate.

Senator PASTORE. Has the statute been discussed by the Commission?

Mr. STRAUSS. The Commission has had the statute before it as a public document at various times, but the Commission has not officially commented on it as a completed document.

Senator PASTORE. Would you leave it then that it is a matter of study that has delayed it, rather than any opposition by anyone in high places?

Mr. STRAUSS. I know of no opposition to it in the administration, Senator. I do not understand that it has been delayed, but simply that it has taken its ordinary course in coming to the Congress.

Senator PASTORE. At this moment I shall pass, Mr. Chairman.

The CHAIRMAN. Mr. Holifield.

Representative HOLIFIELD. Mr. Strauss, I do not have any desire to go into the subject fully of the different reactors which have been referred to here, some planned, some being built, and some being negotiated about. I understand Senator Gore wishes to go into that at some length. But referring to the complete statement in part 8 of the white paper where the first and second and third invitations are discussed, and referring specifically to page 19 of the white paper, under the heading of "First Invitation," I would like to ask you what is the exact status of the three reactor projects enumerated there at the present time. I will ask you what is the exact status of the Yankee Atomic Electric Co., of Massachusetts at this time?

Mr. STRAUSS. Mr. Holifield, with your permission, in order that you may have the most recent and up-to-date information on that, I will ask the General Manager and Mr. Davis, the head of the Reactor Development Division, to respond.

Mr. FIELDS. I suggest that Mr. Davis respond.

Mr. DAVIS. The Yankee project is proceeding. Westinghouse is doing the research and development work and design work on the plant. We had a meeting with the Yankee people about 2 months ago where they gave us a very complete presentation on the status of their project. It does seem to be moving along very well.

On the Power Reactor Development Co. contract——

Representative HOLIFIELD. Just a minute, please. What is the status of the reactor of the Yankee Atomic Electric Co.? Is it in the design stage or planning stage or construction stage?

Mr. DAVIS. It is certainly in the development stage, and also in the design stage.

Representative HOLIFIELD. In the design stage. They have not firmed up their design yet?

Mr. DAVIS. They have done a great deal of the design work. There are certainly quite a few of the details of the core design and things of this sort which must await the outcome of the research and development program.

Representative HOLIFIELD. What was their original estimated cost of this project?

Mr. DAVIS. I believe it was $34.5 million.

Representative HOLIFIELD. Has there been a recent reappraisal upward of the cost?

Mr. DAVIS. We have had some discussions with them to the effect that they expect that a detailed cost estimate that will be made after the design is completed will show somewhat higher costs. We do not know how much, nor do they at the present time.

Representative HOLIFIELD. Let us go to the next one on the page.

Senator GORE. Would the Congressman yield before he leaves the Yankee project?

Representative HOLIFIELD. Yes.

Senator GORE. I have before me a copy of the statement by Chairman Strauss before the committee exactly a year ago, on page 28 where you will find the chart, in which the committee was informed that the completion date, or the estimated completion date, of the Yankee project was in 1959. On page 54 of the presentation today, it is postponed for a year to 1960.

Mr. STRAUSS. Might I comment on that, Mr. Chairman?

The CHAIRMAN. Yes, Admiral.

Mr. STRAUSS. I do not know what specific engineering or other details may have been involved in delays which are common to construction projects, but a year ago at this time, this company and other companies were confident that the Congress would enact the third-party-insurance legislation which the Joint Committee had so nearly unanimously approved, and it is a year since then, and the bills are still in the status of incompleted legislation, Senator. That may have been a contributing factor. These delays are not wholly chargeable to industry.

Representative HOLIFIELD. On that point, do you mean to say that the delay in firming up their design has been due to the fact that they have had no insurance?

Mr. STRAUSS. No. I think that as prudent people they perhaps were looking to see what Congress would do in this matter, hopeful that constructive legislation would be passed, as I am confident it will.

Representative HOLIFIELD. Your remarks would indicate by bringing up the insurance part of the discussion that this has had some effect upon this postponement or the setting forward of the completion date. Is that the position you are taking?

Mr. STRAUSS. No; I think it has an effect on the state of mind.

Representative HOLIFIELD. State of mind, but not upon the state of development.

Mr. STRAUSS. That is right, sir.

Representative PRICE. Would be gentleman yield there?

Representative HOLIFIELD. Yes.

Representative PRICE. I happen to be the author of the first indemnity bill introduced in the Congress last year. I do not think the responsibility for delay in the enactment of such legislation rests wholly on the Congress. I remember that I started to work on the indemnity problem early in the session. It took me a considerable length of time to get a decision out of the Commission on how it felt about such legislation. It was a month after the first bill was introduced before we did get favorable expression from the Commission.

Mr. STRAUSS. May I offer a correction, Mr. Price? The Commission submitted a bill before the final bill of the committee was introduced.

Representative PRICE. That may be true.

Mr. STRAUSS. Our bill on the subject antedated the bill that was introduced, Mr. Price.

Representative PRICE. No. The bill that I introduced was introduced considerably before the Commission came to us with a bill. The Commission came to us with a bill only after we started hearings on the subject. I think the record will bear me out on that.

Mr. STRAUSS. I do not have a sufficiently detailed recollection of the chronology.

Representative PRICE. I am certain that the first formal action on the indemnity provision resulted from a bill which I introduced in the House long before the Commission came up with a bill. It was quite some time after this legislation was suggested before the Commission gave approval to the suggested legislation.

Mr. STRAUSS. I am certain, Mr. Price, that if that is your recollection, it must be correct.

Representative PRICE. I think the record will also show that I was in contact with the Commission before introducing the legislation.

Representative HOLIFIELD. I would like to ask Mr. Davis—as I say, I do not care to go into these different ones in detail, because that will be done later—the present status of Consumers Public Power District of Columbus, Nebr., and their plant. Is it in the design stage, or has there been any construction started on it?

Mr. DAVIS. No, sir; there has been no construction and no really construction type of design.

Representative HOLIFIELD. There is no agreement upon the design?

Mr. DAVIS. There has been no contract negotiated as yet. I think this stems from two things. First of all, that the sodium reactor experiment on which the design and operation of the plant must necessarily be based has been delayed for about a year or somewhat more than a year by technical difficulties.

Representative HOLIFIELD. Mr. Davis, I think we can get along faster—I do not want to be discourteous—I want to establish certain facts, and we can go into the reason why later. If you will just answer the questions, they will be very straightforward without any innuendoes attached to them. I just wanted to know the situation of these three projects under the first round invitation. So if you will just answer the questions I think we will get along quicker.

Mr. DAVIS. The situation on some of these is a little bit complex. That is why I was going into some detail.

Representative HOLIFIELD. I want you to have permission to give such answers as you think are responsive, but I wanted you to know the purpose of my questionwas to establish just the status at this time.

Mr. DAVIS. In this case North American has done some design work, but I certainly would not want to mislead you into thinking that this means that the thing is really in the design stage. Actually it is not. The difficulties there have been the delay in the SRE and the fact that the present estimates of cost are considerably larger than had been contemplated at the start.

Representative HOLIFIELD. We are aware of the updating of costs on all of these projects, practically. That is in the design stage, and has not yet reached the contract or construction stage.

Mr. DAVIS. It is in a very preliminary design stage.

Representative HOLIFIELD. Now, the third item there, the Power Reactor Development Co., Detroit Edison, and others, Monroe, Mich., is that in the preliminary design stage or is it in the completed design stage?

Mr. DAVIS. That is in the design and construction stage.

Representative HOLIFIELD. And the construction goes to what extent? The laying of the foundation of the building?

Mr. DAVIS. They have prepared the foundations and are erecting the concrete and the building to house the equipment which will be tested out there first before it is converted eventually into a nuclear operation.

Mr. STRAUSS. Mr. Holifield, here is a recent photograph, if you care to see it, which indicates the current degree of work on the PRDC.

Representative HOLIFIELD. So in the first round invitation, one company has started its construction, but has not yet completed its design of the reactor.

Going to the second invitation, the Chugach Electric Association, Inc., of Anchorage, Alaska, a 10,000 kilowatt reactor development, what status is that project, Mr. Davis?

Mr. DAVIS. That is at the inception of the research and development.

Representative HOLIFIELD. There has been no design yet for that reactor?

Mr. DAVIS. No design; no sir.

Representative HOLIFIELD. The city of Piqua, Ohio, what is the status of that project?

Mr. DAVIS. The status of that project is that the research and development is being undertaken by North American under their contract with us. As in the case of Chugach, the only design we have is really a conceptual design rather than an engineering design.

Representative HOLIFIELD. That is dependent upon the sodium cooled process?

Mr. DAVIS. No, sir. This is organic moderated and cooled.

Representative HOLIFIELD. That is in the preliminary design stage, then, I assume.

The Rural Cooperative Power Association, Elk River, Minn., what is the status of that?

Mr. DAVIS. The status of that, insofar as American Machine & Foundry is concerned, is that they are proceeding with the design. They have increased the cost, and there is at present no agreement on the cost.

Representative HOLIFIELD. Then there is no contract for the design with the Rural Cooperative Power?

Mr. DAVIS. There is no contract, but A. M. and F. is nevertheless continuing with the design work.

Representative HOLIFIELD. The Wolverine Electric Cooperative of Big Rapids, Mich., what is the status of that?

Mr. DAVIS. Here again we do not have a contract, and I do not believe that any significant amount of design work has been done except for the conceptual design work.

Representative HOLIFIELD. The city of Holyoke gas and electric department is the next one on the list. What is the status on that?

Mr. DAVIS. The last three listed here were all rejected by the Commission, so there is no work in prorgess on any of them.

Representative HOLIFIELD. What three? The city of Holyoke gas and electric department, Orlando Utilities Commission of Orlando, Fla., and the University of Florida have been rejected by the Commission, you say?

Mr. DAVIS. That is correct.

Representative HOLIFIELD. On what grounds?

Mr. DAVIS. The Holyoke and Orlando ones were both rejected on the grounds that the work here was too much in the future. We did not have an adequate research and development basis for committing ourselves to the plant. The University of Florida was rejected primarily because it was not felt to make much of a contribution toward the development of power reactors, since it was such a very small reactor.

Mr. STRAUSS. Mr. Chairman, may I make a comment at this point?

The CHAIRMAN. Yes, Admiral.

Mr. STRAUSS. The rejection of these three proposals, Mr. Holifield, was conveyed to the Joint Committee at the time of the Commission's action—last fall, I believe.

Representative HOLIFIELD. My remark is in no way to be considered as a criticism of the rejection. I am trying to establish on the record certain facts.

Mr. STRAUSS. My point was simply to make it clear that this was not something being brought before the Joint Committee at this juncture. The Joint Committee had been currently informed at the time.

Representative HOLIFIELD. I am aware of that.

Under the third invitation, which was extended to January 7, 1957, has there been any response to the third invitation?

Mr. STRAUSS. May I respond to that, since there are three new items that have just come to my attention? The first is a letter which I received this morning, a copy of which I believe has been sent to you, Mr. Chairman, since the letter states that the signatories are writing to inform you. This is signed by Mr. Philip Sporn, chairman of the American Gas & Electric Service Corp., on behalf of himself, Mr. Kenneth C. Long, Mr. Walter H. Sammis, and Mr. Earl S. Thompson, and representing a group of companies, including besides the American Gas & Electric Service Corp., the Cleveland Electric Illuminating Co. of Cleveland, the Columbus & Southern Ohio Electric Co. of Columbus, the Dayton Power & Light Co. of Dayton, the Indianapolis Power & Light Co. of Indianapolis, the Louisville Gas & Electric Co. of Louisville, and a number of other companies. I have not had an opportunity to read the letter yet. These companies propose to build a prototype of 50,000 kilowatts heat reactor, and invest from 15 to 31 million dollars of their money in that to be completed by 1962, to be followed by a project to be undertaken before 1962 of a reactor to produce 200,000 electrical kilowatts. They say that they have three concepts in mind, all lending themselves to high pressures and high temperatures in exploitation of high thermal efficiencies at the turbine end.

Then there is a statement being issued today by Mr. Paul B. McKee. They say they are submitting this under the third round. Mr. McKee of the Pacific Power & Light Co. issues the statement for himself and his company, the Montana Power Co. and some others. They say they have written to me. I do not have the letter. They have acquired 9,000 acres in the vicinity of Hanford for the construction of a plant.

I also have just received a telegram signed by N. R. Sutherland, president of the Pacific Gas & Electric Co.

Representative HOLIFIELD. Mr. Chairman, I ask that these letters be placed in the record at this point as it pertains to this matter and goes into some detail.

The CHAIRMAN. Without objection, that will be done.

(The letter, statement, and telegram referred to follow:)

FEBRUARY 18, 1957.

Hon. LEWIS L. STRAUSS,
Chairman, Atomic Energy Commission, Washington, D. C.

DEAR MR. CHAIRMAN: As you know, a group of electric utility companies operating in the Ohio Valley and contiguous areas have for many years been cooperating in the power supply of that area. With this background and their common regional interests, it was natural that, in their individual efforts to improve the technology of producing electric energy, a large number of these companies should have joined together to discuss plans for the acquisition of knowledge and experience in the nuclear field.

As a result of these discussions 12 electric utility companies are now formulating plans to undertake jointly a program of nuclear reactor research and development, which, we believe, will represent a significant advance in the technology and economics of utilizing nuclear fuel to produce commercial electric power.

The group proposes first to intensify discussions with the Atomic Energy Commission and manufacturers and to make an evaluation to determine which of several reactor types under consideration by the group should be developed. As described at a later point we have already identified 3 concepts that we regard as particularly attractive for study, and possibly 1 or 2 others may commend

themselves to us before we finally select the reactor to concentrate on. The study and evaluation phase of our work should be completed in the next few months. The group will then formulate a proposal to the AEC. The proposal would contemplate that the AEC participate in the project and share in its cost and benefits.

It is contemplated that our proposal will consist of the necessary preliminary research and construction thereafter by the group of a small prototype reactor having a heat output of about 50,000 kilowatts (equivalent to about 13,000 kilowatts electric power although in our present plans we have not decided that it would be worth while to add a turbine to the prototype). This, it is hoped to complete by 1961 but not later than 1962. Depending on the type selected, the overall program including construction of the prototype is estimated to cost from $15 million to $31 million.

If the research work and prototype develop satisfactorily, it is hoped to undertake well before 1962 the preparation of plans for the construction and operation of a full-scale reactor of up to 200,000 kilowatts of electric power. If all goes well this plant would be consrtucted and in operation 7 to 8 years from now. The group's present plans, however, are limited to the initial phase of research and development and construction of the prototype.

The participating companies are—

American Gas & Electric Service Corp., New York (service organization of the American Gas & Electric System)
The Cleveland Electric Illuminating Co., Cleveland, Ohio
Columbus & Southern Ohio Electric Co., Columbus, Ohio
The Dayton Power & Light Co., Dayton, Ohio
Indianapolis Power & Light Co., Indianapolis, Ind.
Louisville Gas & Electric Co., Louisville, Ky.
West Penn Electric System:
Monongahela Power Co., Fairmont, W. Va.
The Potomac Edison Co., Hagerstown, Md.
West Penn Power Co., Greensburg, Pa.
Ohio Edison System:
Ohio Edison Co., Akron, Ohio
Pennsylvania Power Co., New Castle, Pa.
Southern Indiana Gas & Electric Co., Evansville, Ind.

The three reactor types, all high-temperature designs, now under consideration are—

1. A graphite suspension reactor with ceramic fuel elements, proposed by the Babcock & Wilcox Co.;
2. A liquid-metal-cooled, natural uranium, heavy-water-moderated reactor, proposed by Nuclear Development Corporation of America; and
3. An advanced-type sodium-cooled, graphite-moderated reactor with ceramic fuel elements, proposed by General Electric Co.

In formulating our plans our group has been influenced by the following philosophy: We believe that, important as capital costs are, nuclear fuel costs at least for a long time are not going to be negligible items. We have been impressed with the need to devote much more attention to each element entering into fuel cost, from the delivery of the ore to the final preparation of the fuel. Many of the companies in our group operate in the largest coal-producing area in the United States, the so-called Eastern Fuel Province, and over a number of decades have developed a technology of using coal of the lowest quality burnable (therefore lowest cost) as a basis for bringing about improvements in their power producing costs. We believe this same basic thinking should be introduced into atomic fuel technology. After all, the amount of heat released in the fissioning of an atom or a gram of uranium-235 is independent of the fine quality of workmanship put in on the uranium metal before it is introduced as a fuel element.

At the same time, because of the importance of capital costs in determining the ultimate cost of nuclear power, we intend to stress improvement in thermal economy and the resulting reduction in the reactor size per kilowatt of power as one of the surest roads to lower capital cost. The experience of our group in building conventional plants has repeatedly shown the great contribution that can be made toward lowering of capital costs by reducing the amount of fuel required to generate a unit of electric energy. In its work the group will also seek to stress reactor concepts which do not have inherent limitations on temperatures and pressures. Our aim is to develop a project in which high temperatures and high pressures can be used so as to achieve economies in nuclear

generation just as these characteristics have enabled us to promote advances in conventional power technology.

Because of our philosophy, the three reactor concepts which we shall be evaluating in our study of the next few months are particularly attractive. All three have this in common: They are concepts which lend themselves to high pressures and high temperatures; they are, therefore, concepts which make possible exploitation of high thermal efficiencies on the turbine end. And, as now conceived, they all offer possibilities of using the simplest kind of fuel elements by slight enrichment in two cases and with natural uranium in the other.

The time scale of our program, while apparently long, is in our judgment, and in the judgment of others, in line with the time scale of acquisition of knowledge in parallel technologies with which we are familiar; it is, in brief, not unduly drawn out, but is realistic. We realize, of course, that our plans do not represent the only way of proceeding to develop economical nuclear power. Indeed, there may be no "only" way, and it is necessary to pursue a considerable number of them. But the course we contemplate appears to our group to be the best way for us to contribute our share.

Last Friday afternoon we completed the written agreement of our participating members to the nuclear reactor research and development outlined above. Because of the interest of the Joint Committee on Atomic Energy in developments of this nature, and to place on record with the committee the scope and philosophy of our project, we are today sending a similar letter to the Chairman of the Joint Committee.

On behalf of our group, we wish to thank you for the help and for the many courtesies of yourself and members of the Commission's staff in developing our thinking and our plans for this program. We look forward to working with the Commission in developing and implementing our ideas and plans.

Yours sincerely,

KENNETH C. LONG,
WALTER H. SAMMIS,
PHILIP SPORN,
EARLE S. THOMPSON,
Working Committee of the Group of Companies Indicated.
By PHILIP SPORN,
Chairman.

STATEMENT BY MR. PAUL B. MCKEE, FEBRUARY 19, 1957

Acquisition by Pacific Power & Light Co. of about 14 square miles of land near the Hanford Atomic Energy Works reservation to have a site available for a future atomic powerplant was announced Tuesday, in Yakima, by Paul B. McKee, president of the utility firm.

Part of the 9,000-acre tract has already been purchased and the Pacific Co. soon will exercise the options it holds on the remainder of the land, he stated.

McKee reported that Pacific Power & Light, Washington Water Power, Portland General Electric, and Montana Power Co. have indicated by letter to Adm. Lewis Strauss, Chairman of the Atomic Energy Commission, in Washington, D. C., that the group is actively interested in atomic power possibilities.

All, or part, of this group might be participants in the future construction of an atomic plant on the site which Pacific now has available for such purpose, Strauss was told.

About 35 miles east of Yakima, the site adjoins the eastern boundary of the United States firing range military reservation, and is very close to the Hanford reservation's western boundary. Most of the land is now useful only for seasonal grazing.

The relatively isolated tract lies on the south bank of a curve in the Columbia River a few miles downstream from the Priest Rapids dam site.

The site also is near a key center of power transmission lines at Vernita where both Pacific Power & Light and the Bonneville Power Administration have substations.

"Our company and the others of the group have for more than 3 years been studying the atomic power situation," McKee said. "And we have held a number of serious discussions with the AEC.

"As long as economic hydroelectric developments can be carried on it is obviously in the interest of power consumers of the region that such developments

go forward vigorously. We estimate that it will require about $150 million a year from the 4 companies to carry on their part of the hydro program.

"However, the time is coming when the region will have to turn to thermal energy to keep up with its rapidly growing power requirement," he noted. "At present, atomic power is much more expensive than available hydro but we look for greater progress to be made in reducing atomic costs in the foreseeable future, and we want to be ready to take action at the proper time."

Lack of native oil and gas in the area, and other natural fuel problems, make the possiblities of nuclear energy of special interest to the Pacific Northwest, McKee commented.

Selection of the chosen site followed a survey of possible locations for atomic power developments, he stated. The Pacific Power & Light-Washington Water Power-Montana Power-Portland General Electric group in 1954 entered into an atomic-power study contract with the AEC, and for 2 years had a study team at Hanford.

At the present time, Pacific Power and Washington Water Power are members of the Rocky Mountain nuclear study group, which has a chief of engineers at Idaho Falls, Idaho, where the Arco facility of the AEC is located. In the Rocky Mountain group are 6 electric companies and 4 industrial and engineering organizations.

[Western Union Telegram]

FEBRUARY 18, 1957.

Admiral LEWIS L. STRAUSS,
Chairman, United States Atomic Energy Commission,
Washington, D. C.:

Pacific Gas & Electric Co. alone or in partnership with other California investor-owned electric public utility companies intends to submit a proposal under AEC third round invitation involving a large-scale advanced type pressurized water or boiling water reactor electric powerplant as soon as we can obtain from equipment manufacturers definite price estimates and assurances satisfactory and acceptable to us. We have received preliminary and unofficial figures from Westinghouse and General Electric for equipment and negotiations, and discussions are now in progress in order that definitive proposal may be submitted to AEC.

PACIFIC GAS & ELECTRIC CO.,
N. R. SUTHERLAND, *President.*

Senator GORE. I did not quite understand how many of the three were letters and how many press releases.

Mr. STRAUSS. The last one, from Pacific Gas & Electric is a telegram; one is a letter from the American Gas & Electric Service Corp. and associated companies; and the other is a press release from the Pacific Power & Light Co. associates.

The CHAIRMAN. The letters contain the proposals and should go into the record.

Representative HOLIFIELD. I have not had a chance to read this letter.

Mr. STRAUSS. Nor have I, sir.

Representative HOLIFIELD. I notice that the proposal is to build a 13,000-kilowatt electric powerplant, and if that is successful, that they would come before you some time in 1962 with the preparation of plans for the construction and operation of a full-scale reactor up to 200,000 kilowatts of electric power. If all goes well, this plant will be constructed and in operation 7 to 8 years from now. That is referring to the 200,000 kilowatts. But their present participation is based on a smaller plant of 13,000 kilowatts.

I notice, as you say, that they are considering three different reactor types, and have not yet decided on which one they are going to proceed with.

Is that the only offer you have had under the third invitation?

Mr. STRAUSS. Mr. Holifield, I do not know whether the Virginia-Carolina, Duke, and several others which are listed should come under the third round. In any event, they are proposals that have been received by us since the second invitation was issued, and since the last time we have testified before you. There are a number of them.

Representative HOLIFIELD. Does it make much difference in view of the fact that your third invitation is retroactive to the others.

Mr. STRAUSS. No, sir; I should not think it did. I think that is a purely artificial situation but I did not want to have you feel that they had come in as a result of that. There is another one, the Middle South Utilities. Incidentally, if there is listed in here one from the West Penn Power Co., they are included with the American Gas & Electric. There is no duplication. I was fearful that there was a duplication.

Representative HOLIFIELD. As I understand, these were all in before the issuance of the third invitation.

Mr. STRAUSS. That is correct, and all since Congress had adjourned and since our last testimony before your committee.

Representative HOLIFIELD. On page 21 of your statement, under the heading of third invitation, you say no limitation has been placed on the types or sizes of plants which may be proposed, except that they should make significant contribution toward the achievement of commercial utilization of nuclear power and that construction will be completed by June 30, 1962.

My question on this is that this is a very broad invitation, is it not, and you are purposely making it broad so that all types and sizes of plants can come in under this third invitation?

Mr. STRAUSS. Your assumption is correct, Mr. Holifield.

Representative HOLIFIELD. Now, on page 22, under the numeral paragraph 1, there is contained this language:

> Duplicates of nuclear powerplants already built or under construction. Such plants would advance the overall development of the American atomic industry and for that reason would qualify for the waiver of use charges. An example might be another Yankee-type pressurized water reactor powerplant utilizing the same fuel elements.

As I understand this particular paragraph, this would make available for the third-round incentives any plant which is now planned or under construction, whether it was in existence either in planning or construction prior to the issuance of the third-round invitation or not. It could be a duplicate plant of a type either under planning or under construction. Is that true?

Mr. STRAUSS. I think it is true with this qualification, Mr. Holifield. The industry and the art are so new that a duplicate plant, the construction of which is begun a year or more after the first plant has been completed, is bound to have many details in construction and design which are great improvements over the earlier prototype. These improvements tend to reduce not only the capital investment per installed kilowatt but the operating cost. A somewhat startling example of that is the difference between Yankee and Shippingport, both of which are pressurized water reactors.

Representative HOLIFIELD. I am not criticizing. I am merely seeking to establish the fact that a duplicate of a plant already built or

under construction could be considered under the third round invitation.

Mr. STRAUSS. For the time being, at any rate, Mr. Holifield, the commission will consider each of these projects on its merits as it is submitted.

Representative HOLIFIELD. What appreciable benefits are available to any of the plants that are approved under the third round, whether they be new plants or plants already in contemplation or under construction, are extended to them which were not extended under the first and second invitations? Could you enumerate them?

Mr. STRAUSS. Let me consult the General Manager with respect to that question.

Would you mind restating the question, Mr. Holifield, to be sure we understand what you mean?

Representative HOLIFIELD. What additional incentives are being offered under the third invitation which were not offered under the first and second invitations? I understand that there are additional incentives. I seek to have enumerated at this time the incentives which are being offered.

Mr. FIELDS. I do not recall any additional incentives that have not been awarded to the previous rounds, Mr. Holifield. The principal ones here are waiver of use charge and assistance in research and development, depending on a review of their proposal. The waiver of use charge has been given in the first and second rounds.

Representative HOLIFIELD. When you say waiver of use, you are referring to the use of fuel elements?

Mr. FIELDS. That is correct, sir, of the enriched fuel that is on lease to them.

Representative HOLIFIELD. Had you contemplated reprocessing the fuel?

Mr. FIELDS. There is one additional one I am reminded of, sir. There is a waiver of the charge on heavy water.

Representative HOLIFIELD. I was going to get to that. Under the previous two invitations there was a waiver of use. Was there also a waiver of cost of processing the spent fuel elements?

Mr. FIELDS. There were some firms, as I recall—and I would like Mr. Davis to check me—who requested this, but this was not granted, sir. That is, a waiver of the charges for processing.

Representative HOLIFIELD. Is it granted under the third invitation?

Mr. FIELDS. No, sir.

Representative HOLIFIELD. There is a charge for processing?

Mr. FIELDS. Yes, sir. It is contemplated that there would be.

Representative HOLIFIELD. Then your real addition is the provision of heavy water.

Mr. FIELDS. That is correct.

Representative HOLIFIELD. On a free use the same as the fuel elements.

Mr. FIELDS. Free use, but they would have to pay for losses or consumption.

Representative HOLIFIELD. With a payment for loss or consumption?

Mr. FIELDS. Yes, sir.

Representative HOLIFIELD. Do you consider that a considerable incentive?

Mr. FIELDS. It could be.

Representative HOLIFIELD. Does it amount to quite a large sum financially?

Mr. FIELDS. It is my understanding, it would be for a reactor that used substantial quantities of heavy water.

Representative HOLIFIELD. Is there any reason why the price of heavy water should not be placed on the record at this time?

Mr. FIELDS. None whatsoever.

Representative HOLIFIELD. It is unclassified?

Mr. FIELDS. That is correct.

Mr. STRAUSS. It has been announced.

Mr. FIELDS. It is $28 a pound.

Representative HOLIFIELD. Is there any reason why the number of pounds utilized in a 100,000-kilowatt reactor should not be estimated at this time?

Mr. FIELDS. We would have to give a bracket for it. It might vary, depending upon the design. I would like to ask Mr. Davis to suggest a range here.

Mr. DAVIS. It depends an awful lot on the particular design. It would seem to run around in the general neighborhood of two pounds of heavy water per electrical kilowatt. That is a rough but pretty good figure.

Representative HOLIFIELD. Has the price of the fuel been publicly announced?

Mr. STRAUSS. Not the rods, sir.

Mr. FIELDS. The price of the enriched uranium, yes, sir, and the buy-back prices on plutonium or uranium 233.

Representative VAN ZANDT. Could you give us those prices?

Mr. FIELDS. The prices on the uranium 235 enriched varies with the enrichment. So you have a schedule of prices, and this has been published. To get a handle on it, it is $16, approximately, per gram for uranium enriched to 20 percent, that is, in uranium 235.

The buy-back prices for plutonium are $12 a gram. It has to meet certain specifications as to purity and so forth. For uranium 233, as nitrate it is $15 per gram of uranium 233.

Representative HOLIFIELD. I do not want to go into the pricing problem at this time.

Mr. FIELDS. All of this has also been transmitted to the committee.

Representative HOLIFIELD. I am certain it has. I want to get it on the record. I do not want to go into the pricing completely, but if you could respond to this question, we will leave it at that. I would ask you this question. Are these prices arrived at by recognized accounting practices of cost analysis, or are they arbitrary prices?

Mr. FIELDS. They recognize cost-accounting practices in the atomic-energy program, sir, and are on the basis of full cost recovery.

Representative HOLIFIELD. Now, Mr. Strauss, at the bottom of page 22, under item 3, you have there this language:

> The development and construction of demonstration nuclear powerplants of promising new types for which no prototype project has been started but which represent the application of relatively well developed technology—

and you have similar language beginning with enumerated paragraph 4.

Mr. STRAUSS. I might observe that sentence has no predicate. It has to be read in connection with the first two lines, the sixth and seventh lines on page 6.

Representative HOLIFIELD. Would you read it as you prefer to have it recorded in the record?

Mr. STRAUSS. Reactor projects which might qualify for such assistance under the third invitation will probably take one or more of the following forms: 3. The development and construction of demonstration nuclear powerplants of promising new types for which no prototype project has been started but which represent the application of relatively well developed technology. I did not understand it when I first saw it.

Representative HOLIFIELD. All of these numbered paragraphs refer back to the heading.

Mr. STRAUSS. That is right.

Representative HOLIFIELD. No. 4, the development and construction of demonstration nuclear powerplants based on other reactor types which may or may not be under current development or study.

Mr. STRAUSS. That is right.

Representative HOLIFIELD. As I understand it, in paragraph No. 3 that refers to the development and construction of new types. Paragraph 4 includes types which may or may not be under current development or study at this time. Is that true?

Mr. STRAUSS. That is right, sir.

Representative HOLIFIELD. In placing the word "construction" in there, did you intend to convey that under the third round you could go in to the Nebraska power project, in case that is approved, and complete their reactor for them, that is, actually construct a reactor?

Mr. STRAUSS. Mr. Holifield, the Nebraska project is under the first round.

Representative HOLIFIELD. I know, but under the third invitation you have testified that both the first- and second-round reactors can be considered because the third invitation applies retroactively to all projects either planned or under construction.

Mr. STRAUSS. I think I can answer your question in this way without committing my colleagues——

Representative HOLIFIELD. Did I have the right understanding?

Mr. STRAUSS. Yes, sir. Without committing my colleagues, I would think that was a fair construction. The Commission might conceivably go into a situation—let us not say Chugach, but a comparable situation—including a new type, and put up most of the money for it.

Representative HOLIFIELD. But that is not limited only to a new type.

Mr. STRAUSS. That is right.

Representative HOLIFIELD. Because under paragraph No. 4 you also say, "Based on other reactor types which may or may not be under current development or study."

Mr. STRAUSS. That is right.

Representative HOLIFIELD. As I understand now under the third round, you are widening it not only from the standpoint of furnishing heavy water, but you are also widening it to the extent that you could conceivably go in and construct a nuclear powerplant of either a new or an old type.

Mr. STRAUSS. You mean we go in and construct? No, sir. The difference is whether it is a contractor.

Representative HOLIFIELD. I understand you could do it by contract.

Mr. FIELDS. Mr. Holifield, in this third round we do not contemplate assistance in the form of funding for capital plant.

Representative HOLIFIELD. The language here, the development and construction of demonstration nuclear power plants, would lead me to that thought.

Mr. FIELDS. Could Mr. Davis explain this section?

Mr. DAVIS. Mr. Holifield, I think I was probably the author of the words. The implication of development and construction goes back to the first sentence, which says reactor projects which might qualify for such assistance will be those which involve the development and construction. In other words, what we are supporting here with research and development assistance is somebody who is going to develop and construct a reactor. We are supporting only the development phases of it under the third round. Considering paragraphs 3 and 4; in paragraph 3 we were trying to indicate that normally we would be giving research and development support to a project which was an application of technology which we had, that is, we had reactor experiments or basic technology, which could then be applied to the development of this to a commercial plant. In paragraph 4, we were trying to raise the point that if people were coming in with even more exploratory projects, on which we did not yet have adequate research and development bases, perhaps they should come to us not for assistance under this program, but simply for a research and development contract, such as we write with many people who undertake basic and exploratory research and development of reactor types. This is the distinction we were trying to make between paragraphs 3 and 4.

Representative HOLIFIELD. So this should be read and understood as relating to the research and development section 31?

Mr. STRAUSS. If you will refer to the last paragraph on page 21, you will note that the assistance to be provided under the third invitation is of three general types. These types are waiver of established Commission charges for the use of source and special nuclear materials over a specified period of time, performance either with or without cost at less than full cost in Commission laboratories of mutually agreed upon research and development not reasonably available elsewhere, and third, support of research and development required to advance the technology of projects, and so forth.

Representative HOLIFIELD. The point I wish to clarify, going on from that to the development and construction, was whether the construction of any plants was contemplated under this language.

Mr. STRAUSS. Construction; no.

Representative HOLIFIELD. Actually the brick and mortar construction is not contemplated?

Mr. STRAUSS. No, sir.

Senator GORE. Would the Congressman yield?

Representative HOLIFIELD. Yes.

Senator GORE. It would appear from the statement of the Chairman that if he finds it necessary to further feather the bed of private concerns in order to entice them to submit proposals that you propose

to add feathers to the bed of those with whom you entered into contracts even as far back as 1955.

Mr. STRAUSS. Senator Gore, I do not regard this invitation as an enticement or as providing for feathers.

Senator GORE. I think the Chairman's position in this matter is more explicitly stated in his statement which was released on December 11, 1956. I would like to read one paragraph from that, and I will read the entire paragraph so that there will be no question of taking anything out of context. It is on page 11.

> There is both need and opportunity to move ahead at an accelerated pace, not only in actual construction of full-scale experimental and prototype nuclear powerplants, but also in expanding our store of technology by means of more complete research and development. Therefore, I am proposing that the Commission substantially increase the existing opportunities for Government assistance in this respect by assuming a greater share of the cost of research and development as distinct from the actual construction cost. This extension of Government assistance in addition to the Commission's own experimental projects would apply not only to proposals found acceptable under the new third round of the power demonstration program, but also the projects already initiated under the earlier first and second rounds. I am confident that such Government support for research and development will have a highly encouraging effect on the rate of progress of the entire nuclear industry. It would involve not alone the design of reactors themselves but the improvement of materials, cheaper and longer-lived fuel elements, reactor physics, heat transfer methods, fluid mechanics, chemical processing, waste disposal, reactor safeguards, and many other things that go to make up the broad challenge of cheap, plentiful, and safe nuclear power.

Mr. STRAUSS. Senator, I think that speech from which you have quoted and which was followed by the Commission's third round is entirely consistent with the third proposal, and I would not attempt to set myself up against you as an interpreter of words. But I had always regarded encouragement and enticement as having very different meanings.

Senator GORE. Thank you, Mr. Chairman. I thought that was a more explicit delineation of the position.

Representative HOLIFIELD. Mr. Chairman, I confess I have a great many more questions, but I think it would be unfair at this time for me to persist in my line of questioning. I am hoping that Admiral Strauss will be before us to give us a chance other than just the limited time of this morning's session. So at this time I will yield.

Mr. STRAUSS. I welcome that, Mr. Holifield. Thank you very much.

The CHAIRMAN. We have complications as usual in that we have a controversial measure on the floor of the House at 12. So I believe it is to the best interests to adjourn at the present time and come back at 2 o'clock this afternoon.

(Thereupon at 12 noon, a recess was taken until 2 p. m., the same day.)

AFTERNOON SESSION

The CHAIRMAN. The Joint Committee will come to order.

When the committee adjourned, I believe Mr. Holifield had the floor.

Representative HOLIFIELD. I relinquished the floor.

The CHAIRMAN. Senator Gore.

Senator GORE. Thank you, Mr. Chairman.

Mr. Strauss, if you will turn to page 6 of your statement, I would like to ask you a few questions with regard to that page.

What is the size of the boiling water reactor that became operative at Argonne Laboratory on February 9 last?

Mr. STRAUSS. Senator Gore, it is connected with a 5,000-kilowatt generator, but the statement was made to us at Argonne—confirming what we had understood previously—that it would operate at 10,000 kilowatts. There is, however, only a 5,000-watt generator presently connected with it.

Senator GORE. This is an entirely Government-owned reactor?

Mr. STRAUSS. Entirely Government owned, and Government operated, supplying the power to the laboratory at the Argonne.

Senator GORE. It is entirely Government owned and constructed on a Government site and, as you say, all of its power is being consumed by the Commission facilities.

Mr. STRAUSS. That is correct. It is not an economic size for an industrial operation.

Senator GORE. You recognize, of course, that that is the identical manner in which I and others have proposed that a small number of intermediate sized and large-scale reactors be constructed and operated.

Mr. STRAUSS. No, Senator; I do not regard this as either a large size or intermediate. This is about as small as a reactor of this sort could be built and still get any useful information from it.

Senator GORE. I was not, Mr. Chairman, undertaking to describe this reactor as either large or intermediate. I too regard it as quite a small experimental type of reactor.

Mr. STRAUSS. That is right, sir.

Senator GORE. The point I was trying to make is that it is a reactor that is owned by the Commission, constructed by private enterprise under contract with the Commission, and constructed on a Government site and its output used entirely by the Commission.

Mr. STRAUSS. That is correct.

Senator GORE. And the point I was trying to suggest to you is that it is in identically this same way that I and others have suggested that the atomic power program could be accelerated by the Commission proceeding with contracts with private enterprise to build both intermediate and large-scale reactors.

Mr. STRAUSS. I, of course, do not know what was in your mind, Senator. It was not the way I construed your legislation of last year.

Senator GORE. We will not debate that legislation. I have made that particular point. I would like to inquire if the Commission has or if there is in the United States another reactor producing power in the quantities of 5,000 kilowatts or more.

Mr. STRAUSS. Yes; there are, but they are not civilian power reactors.

Senator GORE. Eliminating military or eliminating the Nautilis.

Mr. STRAUSS. I would also have to eliminate the *Nautilus* prototype, the *Nautilus*, and the *Sea Wolf* prototype and the *Sea Wolf*.

Senator GORE. All right. Then let me rephrase my question. Is there another reactor in the United States privately owned or Government owned other than the submarine-type reactors that is, or has, or is producing or has produced, electricity to the extent of 5,000 kilowatts?

Mr. STRAUSS. No; there is not, Senator.

Senator GORE. This is the only one we have then, of 5,000 kilowatts?

Mr. STRAUSS. It is the first, Senator.

Senator GORE. Did you happen to see the movie shown at the Geneva Conference in 1955 by the Russians of a reactor which allegedly produced 5,000 kilowatts or more?

Mr. STRAUSS. I did.

Senator GORE. Now, further down on page 6 you say:

> Before the current calendar year is ended, 5—and perhaps 6— reactors (including the boiling water reactor) will be delivering electrical power in the United States at various points from coast to coast.

I would like to inquire a little about those five. You include the boiling water reactor at Argonne, and we will call that one of them.

Mr. STRAUSS. Yes, sir; Senator.

Senator GORE. That is a government-owned reactor.

Mr. STRAUSS. That is right.

Senator GORE. We described that one.

Mr. STRAUSS. Yes.

Senator GORE. Now, you list also the Army package powerplant at Fort Belvoir.

Mr. STRAUSS. That is right.

Senator GORE. That is a Government-owned reactor.

Mr. STRAUSS. It is.

Senator GORE. You list the North American Aviation sodium reactor built for the Commission by the North American Aviation Co. at Santa Susana, Calif. That too, I believe, is a Government reactor.

Mr. STRAUSS. The North American Aviation Corp. made a substantial contribution to that reactor.

Senator GORE. It is Government-owned reactor.

Mr. STRAUSS. That is right.

Senator GORE. Then you list the homogeneous reactor at Oak Ridge.

Mr. STRAUSS. That is a reactor built in our own laboratory as an experiment, with Government funds, and it is, of course, Government owned.

Senator GORE. That is four of them.

Now, you list Shippingport.

Mr. STRAUSS. That is a reactor to which the Duquesne Light Co. contributed $5 million, and the Westinghouse Co. contributed its profit, and the Duquesne Light Co. contributes the operating expenses, the site, and all the generating equipment.

Senator GORE. What is the contribution of the United States Government?

Mr. STRAUSS. The reactor.

Senator GORE. Then the reactor is Government owned.

Mr. STRAUSS. It is Government owned, but toward the cost of that reactor the Duquesne Light Co. contributed $5 million.

Senator GORE. Then if we have a mortal fear of a Government-owned reactor——

Mr. STRAUSS. Do not impute a mortal fear to me on this subject, Senator, I haven't any mortal fear.

Senator GORE. I did not mean mortal fear. I do not know just what it is. It is a little hard for me to describe. But I will withdraw that suggestion.

Mr. STRAUSS. Thank you.

Senator GORE. That leaves one then. The Shippingport reactor was constructed by terms of the original McMahon Act which was superseded by the act of 1954.

Mr. STRAUSS. The contract with the Duquesne Light Co. was executed in the spring of 1954, when the McMahon Act was in force; the current Atomic Energy Act was passed in August of that year.

Senator GORE. Which means that the Shippingport reactor was begun under terms of the act which was repealed or superseded by the 1954 act.

Mr. STRAUSS. That is right, sir.

Senator GORE. Will you give us the cost of the Shippingport reactor?

Mr. STRAUSS. I cannot give you the cost because the reactor is not completed, and no one knows what the eventual cost will be. But there are figures in section 8 indicating estimates of cost which, of course, have overrun original estimates. As you of course know, Senator, from membership on this committee, the very simple reactor built at Brookhaven without any power aspects at all cost, I believe, something like twice as much as the estimates.

Senator GORE. I am aware of that. But would you read into the record for the benefit of the committee and of those present who might be interested, the cost or estimated cost now of the Shippingport reactor?

Mr. STRAUSS. I am informed that it will be in the neighborhood of $55 million, but I would not want that to stand on the record as my estimate of the costs, because I should not be at all surprised if they were higher.

Senator GORE. That is the estimate which your staff furnishes you at the moment?

Mr. STRAUSS. That is only for the reactor and not for the generating equipment which is not an expense of the United States Government.

Senator GORE. Then, of these six which you list, the only possibility of a privately owned reactor which you list as coming into production of power in the year 1957 is the small prototype General Electric plant in California?

Mr. STRAUSS. Senator, may I request that you be good enough to repeat that?

Senator GORE. Again referring to page 6 in which you said some 5, and perhaps 6, reactors would come in. You and I together in exchanges have identified 5 of those 6.

Mr. STRAUSS. That is right.

Senator GORE. All of which are entirely Government-owned.

Mr. STRAUSS. That is right.

Senator GORE. Then the sixth one, so far as I can find, must be the General Electric prototype at Vallecitos, Calif.

Mr. STRAUSS. I am informed that it is entirely owned by the General Electric Co.

Senator GORE. I understand. That would be the sixth one.

Mr. STRAUSS. Senator, I am sure you are aware that if private companies had been prepared to break ground the day after the Atomic Energy Act of 1954 was passed, it would not have been possible to build atomic energy plants and complete them by this time.

As a matter of fact, it takes anywhere from 2½ to 4 years—say 3 years—to build a conventional steam plant.

Senator GORE. I am aware of that. I am trying to identify and clarify the statement, and I understand, Mr. Chairman, that in summarizing this large sheaf of materials you must of necessity make a general statement.

Mr. STRAUSS. I am sorry for its volume. We condensed it as far as we could.

Senator GORE. I was not undertaking to be critical at all. I was recognizing the necessity for you to be both brief and general to present within an hour's time a summary of the material. However, there is so much public interest in this particular subject and as a member of this committee I have so much interest that I did want to clarify the record.

Then of the 6 to which you refer on page 6, only 1 is a private enterprise reactor and that is the small prototype of the General Electric Co. in California?

Mr. STRAUSS. Yes, sir; you are referring only to completed reactors.

Senator GORE. I am referring to your testimony on page 6.

Mr. STRAUSS. That is right.

Senator GORE. We will come to the other parts a little later if I may. Now, would you indicate the size of this prototype powerplant in California?

Mr. STRAUSS. In kilowatts, installed capacity, let us take them one at a time.

Senator GORE. I was only inquiring about the General Electric prototype in California.

Mr. STRAUSS. 3,000 kilowatts, which, of course, is a prototype for a larger plant they are contracting to build for one of the private companies which is to build a full-scale plant at its own expense.

Senator GORE. Now I have only one other question with respect to page 6.

In the second sentence, you say, referring to the Argonne reactor that became operative a few days ago:

> The boiling water reactor thus became the first harvest of the Commission's experimental power program inaugurated 3 years ago to test the feasibility of different types of civilian power reactors.

I have before me a copy of a report of the Reactor Subcommittee, Subcommittee on Research and Development, of this Committee, on March 4, 1954. That is some months before the 1954 act became law, in which plans for this reactor are described. I will read from page 11:

> An experimental boiling water reactor of about 20,000 kilowatts of heat, and 5,000 kilowatts of electricity is planned to explore further the possibilities revealed by the investigations in 1953. Specifications are being established by the Argonne Laboratory.

So this reactor, too, according to this report, was planned and initiated under terms of the act which was superseded by the act of 1954.

Mr. STRAUSS. It was planned under the terms of the 1946 act which was no different from the present act in respect of empowering the Commission to engage in the development of reactors, Senator. I do not know what the significance is in your mind as between the two acts, since in that area the authority and the responsibility of the Commission were identical.

Senator GORE. Well, I will be glad to inform you of one of the points in my mind. I feel that the program under the 1954 act is utterly inadequate to bring about expeditious development of atomic power, that further legislation is necessary unless this country fall further behind than it already is in the construction and operation of large-scale atomic powerplants.

Mr. STRAUSS. Senator, I will have to say that I respectfully differ with you as to this country being behind any other country in the development of power reactors for civilian use.

Senator GORE. You used a little different terminology than I used. Perhaps we might clarify that. I said lest this country fall further behind than we already are in the actual construction and operation of large-scale power reactors.

Mr. STRAUSS. You will, I am sure, permit me to respectfully differ with you, we cannot fall further behind when we are not behind at the present time.

Senator GORE. Do we have a large-scale atomic powerplant in the United States today?

Mr. STRAUSS. We have the only civilian power reactor that is exclusively devoted for civilian purposes nearing completion at Shippingport. I know of no such reactor in any other country.

Senator GORE. My question was, Do we have one single large or do we have a single intermediate size atomic power reactor operating in the United States today?

Mr. STRAUSS. I know of no country that has either a large or intermediate power reactor in operation devoted for civilian purposes. That is, our country or any other country.

Senator GORE. Would you mind responding to my question?

Mr. STRAUSS. I thought I was, sir. I was attempting to.

Senator GORE. Do we have in the United States operating today either a large scale atomic powerplant or an intermediate sized atomic powerplant?

Mr. STRAUSS. No; because I regard the boiling water reactor at the Argonne as small.

Senator GORE. The answer is "No," then?

Mr. STRAUSS. With the qualfiication that I gave you on the definition; yes, sir.

Senator GORE. I was not inquiring about that. I recognize the small plant at Argonne and it became operative on February 9.

Mr. STRAUSS. That is right.

Senator GORE. I am glad that it did. I was a little disappointed that we were nearly 2 years late in having a 5,000-kilowatt reactor operating. That is, nearly 2 years after Russia had a plant of such size.

Mr. STRAUSS. I am sure you know without my reminding you that we have had much larger reactors operating since the summer of 1953, delivering power.

Senator GORE. Well, you are referring now not to an electric-power generator. You are again referring to this submarine reactor?

Mr. STRAUSS. I am referring to electric power, and that is how the city of Arco was lit; the use to which the reactor was applied is not the question.

Senator GORE. How large was the reactor that lit Arco?

Mr. STRAUSS. I cannot tell you, sir, because that is a matter of classified information, military information. I beg your pardon, sir, the borax reactor which lit Arco was 2,000 kilowatts. The prototype reactor for the *Nautilus* at Arco is classified military information.

Senator GORE. I thought the plant that lit Arco was not classified. I had seen that in a number of newspapers and had referred to it myself, and I hoped I had not violated any law.

Mr. STRAUSS. The power from one of those reactors did take care of the laboratory for a short period of time, but the lighting of the city of Arco was performed with a small boiling-water reactor, an experimental reactor.

Senator GORE. Of course, I would not in any way, Mr. Chairman, deny you the privilege of using whatever phrase you desire to use to qualify your statements.

Mr. STRAUSS. I am attempting to make them accurate, and as fully responsive as I can.

Senator GORE. I was not questioning the accuracy or the purpose. I would not deny you the use of whatever phrase you desire. I would claim the privilege, however, of clarifying some of them.

You say that Shippingport, when it becomes operative, will be the first intermediate-size reactor to produce purely and strictly civilian power?

Mr. STRAUSS. That is my belief.

Senator GORE. Is that accurate?

Mr. STRAUSS. That is my belief, Senator.

Senator GORE. Well, you are comparing that, I believe, with the reactors which the British have been operating at Calder Hall, England, and you are distinguishing, are you not, as between the Shippingport plant and the Calder Hall plants on the basis that the Calder Hall plants are or can be dual-purpose reactors?

Mr. STRAUSS. No, sir; I am distinguishing the Shippingport plant from any other plant that I know of anywhere in the world. The Calder Hall plants are primarily designed—and this has been so stated by the head of the British Atomic Energy Authority—for the production of a weapons material. The production of power is a secondary consideration. It is the same, Senator, as if we had taken the low-grade heat which is produced in our reactors at Hanford and at Savannah River and attempted to make use of it at high cost for the production of power.

Senator GORE. Of course, it is acknowledged, and as you say the British have so published, that the reactors at Calder Hall are of the dual-purpose type, in that they can either produce power or plutonium or both.

Mr. STRAUSS. Both, sir. They cannot produce one or the other. They invariably produce both.

Senator GORE. All right, then, both. But flowing from that generator or rather from that reactor, or from those reactors—I understand the second one went critical only a few days ago—is a substantial flow of civilian electricity.

Mr. STRAUSS. That is true, sir.

Senator GORE. And certain members of this committee have for long urged the necessity for a dual-purpose reactor in this country.

Mr. STRAUSS. I was not aware of that fact, but I naturally accept your statement. The Commission some years ago, before I returned

to it, took a position which I believe to have been a sound one. It decided that the dual-purpose reactor did not belong in our reactor complex.

Senator GORE. I will ask the clerk to supply you with a copy of your testimony before this committee a year ago when you likewise gave to the committee and to the country a most encouraging report on developing civilian atomic power. Will you give the Chairman of the Commission a copy of that, and also the members of the committee. It is the chart opposite page 28.

If you will look, Mr. Chairman, opposite page 28 and unfold the chart, it is headed, "Developing Civilian Atomic Power."

In the third column you list "The first round," and there are three reactors listed there.

Now, your presentation this year does not take exactly this form but if you presented the information a year later, or now, what changes would you make in the first round?

Mr. STRAUSS. May I ask that that question be answered by the Director of the Reactor Development Division?

Mr. DAVIS. Senator Gore, on the first round, the three reactors would still stand.

Senator GORE. You have no additions to it?

Mr. DAVIS. On the first round; no, sir.

Senator GORE. Then on page 54 of the presentation this year I find those same 3 listed, and no additions, and the only change is that of the 3; 2 are reported to be completed a year later than they were reported to this committee a year ago. So there is no particular progress there. Is that correct? I refer you to page 54 of this presentation.

Mr. DAVIS. In the case of the Yankee reactor, their original schedule was December of 1959, and when they worked out their schedule this comes out to be sometime early in 1960, so this is a matter of a few months, in a large schedule, and we had originally taken the December date as being the one to use.

Senator GORE. Then the answer is "Yes"?

Mr. STRAUSS. Not a year, Senator Gore.

Senator GORE. You list here on this chart, 1959. In your chart now you list 1960.

Mr. DAVIS. It is in a different year, but it may not be a year's difference.

Senator GORE. The second one is the Detroit Edison reactor, and you report no change at all.

Mr. DAVIS. That is correct, sir.

Senator GORE. Is not that in fact in a state of suspension?

Mr. DAVIS. No, sir; they are proceeding with construction, and——

Senator GORE. Did you not testify this morning that they were constructing test facilities?

Mr. STRAUSS. Senator, we showed a progress photograph of the Detroit Edison project.

Senator GORE. I saw that.

Mr. STRAUSS. There is substantial construction underway.

Senator GORE. I understood Dr. Davis to say they were constructing test facilities.

Mr. DAVIS. May I explain more fully? They are constructing their facility, in which they will carry out the test, but they are going to put in place things like the reactor vessel and some of the equipment and test it first nonnuclear, and then use the same equipment later on hot. This is actually done partially to accelerate the schedule because they had originally planned to carry out these same tests but in a different location.

Senator GORE. When I asked if it was not in a state of suspension, I was referring to the reported lack of clearance by the safety committee.

At least is there not a contested hearing under way as to the safety of this reactor?

Mr. STRAUSS. There is a hearing in progress, Senator. The Commission has given a license to construct, not to operate, and construction is going ahead with no suspension or delay as far as the Commission is aware.

Senator GORE. You have given a construction permit?

Mr. STRAUSS. That is right. It is not in suspension in any way.

Senator GORE. But do you not have a condition that a license for operation will not be given until safety requirements are met?

Mr. STRAUSS. That was a condition we established when we gave the license to construct and it has nothing to do with the construction license.

Senator GORE. Then it is a conditional matter.

Mr. STRAUSS. It is not a suspension, Senator.

Senator GORE. Well, maybe I should have said "conditioned" instead of "suspension." You and I have some difficulty with the meaning of words.

Mr. STRAUSS. It is not a condition having anything to do with the construction.

Senator GORE. But with its operation.

Mr. STRAUSS. Solely with its operation.

Senator GORE. Then, the third one according to your report today shows a completion date 1 year later.

Mr. DAVIS. On consumers. I mentioned this morning that we have had over a year's delay in the completion of the sodium-reactor experiment because of technical difficulties and this is one reactor where we surely need the experience of the reactor experiment before we are really on sound ground to proceed with a large plant. I believe a year is certainly a justified delay in this case.

Senator GORE. I am not being critical about this. I am trying to test the quality of optimism which we had presented to us last year and again this year. I surely hope that the optimism this year is on sounder foundation than the optimism of last year. I will go now, if you will refer to the chart, to the second round.

Last year you listed 7 reactors, by testimony this morning, you have eliminated from those 7, 3.

Mr. STRAUSS. That is right.

Senator GORE. That leaves 4; that is, 4 of the 7.

Now, are there any additions to the second round?

Mr. STRAUSS. No, Senator. There have been some projects which have come in between the second and third round. The period or the time of the second round has elapsed.

Senator GORE. That brings us to the third round about which Congressman Holifield questioned you this morning. How definite a proposal have you had in response to the third round?

Mr. STRAUSS. The time has not elapsed for the presentation of definite proposals but I read this morning certain communications from responsible American industries indicating that third-round proposals would be made by them. This statement also indicates interim proposals that have been made by the New England Power Co., the Duke, Virginia-Carolina Combine, and various other companies.

Senator GORE. I was interested this morning in the portion of the letter from Mr. Sporn and others which was read by Congressman Holifield. As he read the letter the proposal was not to construct a large-scale or even an intermediate-size reactor by 1962, but rather to construct a small prototype by 1962 which if sufficiently successful might be the basis for a proposal to build a large-scale reactor or thereafter.

Now, in view of your announcement that submissions on the third round apply to reactors to be completed by 1962, I wondered if that would meet your test.

Mr. STRAUSS. I think there again we have a matter of definitions. I do not regard a 15,000 electrical kilowatt reactor as small. I regard it as intermediate, Senator. This, again, is a matter of opinion.

Senator GORE. I understood you to say earlier today that the Argonne would produce up to 10, and that you regarded it as very small.

Mr. STRAUSS. It is a 5,000-kilowatt reactor, and I said it was small. I do not believe that I said "very small."

Senator GORE. I withdraw "very."

Mr. STRAUSS. Thank you. With your permission, since you are quoting from the record of the committee, might I call your attention to another report of the Joint Committee issued in early 1953, dated December of 1952, which asks this question on page 39: "Why is there no atomic powerplant in existence or under construction today?" and which, at the outset of the report, calls attention to the fact that there is no major project whose purpose is to achieve a reactor directly advancing industrial power, and to invite your attention to the fact that everything that we have testified to has occurred in the intervening 4 years, which accounts for the enthusiasm that I have for the program.

Senator GORE. I for one, and I am sure all members of the committee, respect your enthusiasm and your ability to present an interesting point of view, in an interesting and engrossing manner.

Now at another part of your statement you referred to 18 civilian nuclear power reactors. I believe it is on page 21, Mr. Chairman.

On page 21 of your statement today you say:

> As to power reactors, it is significant that as 1957 opens there are underway in various stages of construction, discussion, or negotiation plans for at least 18 civilian nuclear powerplants in the United States to come into operation not later than 1962.

Now I find almost a verbatim sentence in a statement you made on December 11. I will read from that, on page 6:

> There are plans in various States of discussion or negotiation for at least 18 civilian nuclear powerplants in this country to come into operation by 1962.

Were you referring to the same 18 in both statements?

Mr. STRAUSS. I was referring to the same 18 but this morning I think I changed my testimony to read 19. In other words, in my oral testimony I added one plant beyond those which were in the prepared testimony sent to the committee yesterday or the day before.

Senator GORE. I believe, Mr. Chairman, your memory may be slightly in error. I will read the second sentence in your statement of this morning:

> These projects include the 17 listed as of January 2, 1957, at pages 54 and 55 of section VIII of the written testimony and the project announced by Northern States Power Co. on February 8.

So the addition you made this morning or in your testimony this morning, I believe I recall was the Northern States Power Co. announced on February 8.

Mr. STRAUSS. You have the advantage over me; you have the transcript of my remarks, and I will gladly accede to you the correctness of this arithmetical tabulation, because I do not have the testimony. I will be delighted to read you the list of these plants and companies, and you can tabulate them yourself.

Senator GORE. You may be sure, Mr. Chairman, that I wish no advantage, and on the contrary feel that I am at a great disadvantage in exchanges with you, an expert, and administrator of this powerful program. I did find it a matter of interest that you will use almost verbatim language in referring to 18 reactors to come into production in 1957.

Mr. STRAUSS. No, sir; that is not right.

Senator GORE. Excuse me—1962. But one of those about which you spoke in December was only announced by the Power Co. itself on February 8. That is just a matter of curiosity to how you knew about that.

Mr. STRAUSS. They had come and talked with us about it. We have an obligation to keep you fully and currently informed, and a conversation of that sort I think is a material matter.

Senator GORE. Would you mind informing the committee if 1 of these 18 reactors is for a merchant ship?

Mr. STRAUSS. It is, sir.

Senator GORE. How many of these 18 are in fact to produce nuclear power for civilian use.

Mr. STRAUSS. Let me look at the list, and answer your question—19, sir.

Senator GORE. Nineteen of these?

Mr. STRAUSS. I mentioned 19 this morning, and I still think that my recollection of using the figure 19 is correct recollection, and I will be glad to read them off to you. I had this paper before me when I testified and it is possible that my tongue slipped and I said 18, but 19 was the figure I intended to give, and perhaps some of those who are sitting here with me will bear me out.

Representative COLE. I can bear you out. You said 19, and I made a correction in the manuscript.

Mr. STRAUSS. Thank you, sir.

Senator GORE. Then you are listing as a civilian power reactor a reactor to propel a merchant vessel?

Mr. STRAUSS. Is there any other definition that you can give it? It certainly is not a military power reactor, Senator. This is a vessel

for peaceful civilian use, and I did not know any other classification under which to put it.

Senator GORE. Well, Mr. Chairman, you declined to classify a reactor that would produce plutonium and power as a reactor to produce civilian power.

Mr. STRAUSS. No; I declined to classify it as a reactor for exclusive civilian purposes. You and I seem to have a great deal of difficulty on definitions, and I regret it. But I will attempt to make this as clear as I can. A reactor which is primarily erected to produce weapons material is not by my definition—and I concede that it is a personal definition—a reactor for exclusive civilian use. A reactor to power a merchant vessel is in my opinion, Senator, a reactor for exclusive civilian use.

Senator GORE. I did not say civilian use. I said civilian power, electric power.

Mr. STRAUSS. For civilian power, I regard that as a reactor for civilian power.

Senator GORE. Electric power?

Mr. STRAUSS. Yes, sir.

Senator GORE. Even though it is used to propel a turbine and a propeller to move a ship?

Mr. STRAUSS. That is right, sir.

Senator GORE. Then that is not to produce electric power to be used by the people of the United States in their homes and in their factories, you would not say that?

Mr. STRAUSS. Senator, I beg your pardon. I was not attentive to your question at that moment.

Senator GORE. Perhaps my question was entirely superfluous. I was inquiring if you would go so far, as I am sure you would not, to say that a merchant ship reactor is for the purpose of producing civilian electric power to be used by the people of the United States in their homes and in their factories?

Mr. STRAUSS. With that final qualification, that it is to be used in their homes and factories, I could not make that distinction or that statement. That is, of course, a refinement of the definition beyond the point that I had taken.

Senator GORE. I would like to get back to this question of whether it is 17, 18, or 19, and perhaps it is not important. But neither I nor my staff can count up quite that way. If you will refer to page 54 and 55 in section 8 and count, I believe that you will find that there is some point in the number I used. It is taken from your own records.

Mr. STRAUSS. Senator, if this would assist in getting ahead with the hearing, I will gladly strike out one of these numbers and settle for 18 or 17. I think that they are substantial figures. I have a list of them here. I am unable to reach your total, and you are unable to reach mine, and we could get together on it after the hearing if you wish or I can read the names off to you.

Senator GORE. It would not take long for you to count the 17, or 18, or 19. Will you count them?

Mr. STRAUSS. I had read the list that I have here before me, sir.

It begins of course with the six plants that we testified would come onstream, we expected, within this calendar year.

Under construction, discussion, or planning, are the following:

The Power Reactor Development Corp.'s plant in Detroit, 100,000 kilowatts.

The Yankee Electric Co.'s plant at Rowe, Mass., 134,000 kilowatts.

The Consumers Public Power of Nebraska, 75,000 kilowatts.

The Rural Cooperative of Minnesota, 22,000 kilowatts.

The Wolverine Company of Michigan, 10,000 kilowatts.

Chugach Company of Anchorage, Alaska, 10,000 kilowatts.

The city of Piqua, Ohio, 12,500 kilowatts.

The Commonwealth Edison Company of Illinois, 180,000 kilowatts.

The Consolidated Edison Company of New York, 140,000 kilowatts.

The Pennsylvania Light & Power Co., 150,000 kilowatts.

The Florida Power Corp., 200,000 kilowatts.

The New England Electric Co., 200,000 kilowatts.

The Carolina-Virginia Power group, 10,000 kilowatts.

The Middle South utilities group, 20,000 kilowatts.

Northern States power group, 60,000 kilowatts.

Nuclear merchant ship, 16,400 kilowatts.

The Pacific Power & Light Company Associates have not yet communicated an amount. The Pacific Gas & Electric Co., in the telegram which I read this morning, gave the figure of 200,000 kilowatts, and the American Gas & Electric and associated companies, if you will recall, cited 13,000 kilowatts for the initial plant, and 200,000 kilowatts for the objective plant.

While I may be wrong about this, I total 19, but I will settle for 18.

Senator GORE. You said in your statement that you referred to the 17 on page 54 and 55, and there are 17 there according to my count.

Well, with a view of eliminating some of these 19 or it may be 18 in the spirit in which you suggest, I suggest that you might also eliminate Middle South Utilities. How firm is that reactor proposal?

Mr. STRAUSS. They simply stated that they planned to build it at their own expense.

Senator GORE. Was it a press release? Do you have anything more than a press release?

Mr. STRAUSS. We do not.

Senator GORE. But you count that as a reactor?

Mr. STRAUSS. I count it as a projected reactor; yes, sir. If I omitted it, it would be an act of omission for which I would not care to be responsible.

Senator GORE. Let us see how you count it. I think it is something more than a remote possibility as you interpret it in your statement.

I will read it, on page 21, your statement read this morning:

> As to power reactors, it is significant that as 1957 opens there are underway in various stages of construction, discussion, or negotiation—

and I want to compliment you on your ability to tie words together in a most meaningful way—

> plans for at least 18 civilian nuclear powerplants in the United States to come into operation not later than 1962.

This Middle South Utilities reactor on which you have had nothing but a press release, you have included that one.

Mr. STRAUSS. They have come in and talked to us about it. They have also engaged the services of a consultant to your committee who is a very distinguished nuclear scientist, Dr. Zinn.[1]

Senator, all projects of any moment begin with discussion and proceed to negotiation, and then to construction. I am sure you concede that there has to be a beginning, and I have before me what purports to be their press release. I will be glad to read it into the record if you would care to see it. So far as I know, this is the first time I have ever seen anything except the actual newspaper reproduction of it. But here it is.

Senator GORE. You counted it as one of the 18?

Mr. STRAUSS. Pardon me.

Senator GORE. You have seen nothing but a newspaper?

Mr. STRAUSS. I told you that they had been in to talk with us, in person. And they have also engaged Dr. Zinn, and Dr. Zinn has talked with us.

Senator GORE. But you list it in your report here. What I am trying to say, Mr. Chairman, is that the people of the United States read what you say, and I am glad they do. But in reading this statement which I will again read to you to refresh your memory:

> As to power reactors, it is significant that as 1957 opens there are underway in various stages of construction, discussion, or negotiation plans for at least 18 civilian nuclear powerplants in the United States to come into operation not later than 1962.

Mr. STRAUSS. I think that is a factual statement, Senator. If any other reputable company made the statement that his group of companies has made, I would have included it. The companies in this group are the Arkansas Power & Light Co., Louisiana Power & Light Co., and the New Orleans Public Service, Inc.

Senator GORE. Then would you break down for the benefit of the people of the country the number that are in the construction stage, and the number that are in the discussion stage, and the number that are in the negotiation stage, and the number that are in the press release stage?

Mr. STRAUSS. I would be very glad to respond to that question, sir. I do not believe that a press release stage is a stage which we would recognize as such except for purposes of information to you, and I will ask Dr. Davis to list those plants which are under construction, those plants for which negotiations with the Commission have started but for which construction has not yet started, and those plants of which we have been notified in one way or another that they are under discussion.

Will you undertake to do that, Doctor?

Senator GORE. Are you prepared to do that now, Dr. Davis?

Mr. DAVIS. I can go down the chairman's list, and tell you the status of them, I believe.

Senator GORE. Well, I notice on the chairman's list, on page 55, that the New England Electric System is scheduled to be completed not in 1962, but in 1964. I notice that the Carolina-Virginia Nuclear Power Associates, and Middle South Utilities, Inc., have no completion dates at all.

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[1] Dr. Zinn's status as consultant to the Joint Committee terminated July 1, 1956.—Editor.

Mr. STRAUSS. Senator Gore, the New England Power Co. has not submitted a proposal to us under the third round. They are entitled to make their plans to complete a reactor at any time they please.

Senator GORE. But Mr. Chairman, you said in your statement which I have now read twice——

Mr. STRAUSS. Sir?

Senator GORE. I have just read for the second time your statement, in which you list them as 1 of the 18 civilian nuclear powerplants in the United States to come into operation not later than 1962.

Mr. STRAUSS. Well, I have 18 without that company, sir.

Senator GORE. I think that you must be in error there. I believe that you had both of them in your list there a moment ago.

Mr. STRAUSS. Will you give a list of those, in answer to the Senator's question?

Senator PASTORE. Will the Senator yield for a question? Do I understand Dr. Davis to say that he is prepared now to give us the status of each one of these projects?

Mr. DAVIS. I can go down the list, Senator, and tell you what I know about each of them.

Senator PASTORE. How far they have gone?

Mr. DAVIS. Yes, sir.

Senator PASTORE. Would that not be a good idea?

Mr. STRAUSS. I think the record should show here that the Commission can make no guaranties; we can simply state what the companies have said.

Senator PASTORE. I realize that. But I think it is quite interesting to know just about how much has been done on each.

Senator GORE. Dr. Davis, instead of following a list of which the committee members have no copies, will you take the list submitted to the committee by the Commission, listed on pages 54 and 55? I believe we can follow it better.

Mr. DAVIS. I think we covered the Power Reactor Development Co. one this morning, which is actually under construction.

The Yankee Atomic Electric Co. plant is under design and the development is being carried out by Westinghouse in accordance with our contract.

Senator GORE. It was testified that it was under preliminary design.

Mr. DAVIS. I testified the Yankee one was actually under design.

Senator GORE. All right.

Mr. DAVIS. The Consumers Public Power District one as we have related is still under negotiation, preliminary designs are being made by North American, but we still do not have a contract between the two parties involved. This has been delayed by virtue of the experience with the SRE, and the cost situation.

The Rural Cooperative Power Association is still again in question so far as the schedule is concerned, but presumably if we can negotiate a new contract with the new prices the schedule will probably still be precisely the same. We have no evidence that it will change from the dates stated here.

Chugach and Piqua are still in the stage of research and development, and we believe that these dates are still firm, but of course these again will hinge upon the results of research and development which as yet has to be completed.

In the case of organic moderated reactor for Piqua, the city of Piqua, Ohio, we should have in operation this summer a reactor experiment out at Idaho which is nearing completion now. We hope that will demonstrate the feasibility of this type of reactor.

Senator GORE. But your actual Piqua reactor is not even in the design stage. It is dependent upon the successful operation of a prototype.

Mr. DAVIS. That is entirely correct, Senator.

Senator GORE. All right.

Mr. DAVIS. The General Electric Co. and Pacific Gas & Electric Co., boiling water reactor at Vallecitos is nearing completion or is very well along the road toward completion.

Senator GORE. What size is that?

Mr. DAVIS. That is 3,000 kilowatts. I should say that 3,000 kilowatts is the size of the turbogenerator and the reactor, as an experiment, will probably put out more heat.

Representative PRICE. How long has that been under construction?

Mr. DAVIS. Since sometime last summer, I believe, Mr. Price.

The Duquesne reactor, and the Shippingport reactor, I think we have covered fairly well. It is nearing completion.

The Commonwealth Edison Co. reactor—they are actually under construction and the detailed design is reported to be nearing completion.

Consolidated Edison Company of New York—again their work is underway at the site and the design work on that is well along.

Senator GORE. Is that preliminary design?

Mr. DAVIS. That is the detailed engineering construction design.

Senator GORE. When do you think the design will be completed?

Mr. DAVIS. I do not recall the figure offhand, sir.

The nuclear merchant ship reactor has been under design for some time. We are trying to finish up our contract negotiations at the present time.

The Pennsylvania Power & Light Co. reactor—they are in the middle now of a very large and extensive research and development program, entirely at their own expense, and plan to start the detailed design of this reactor in 1958.

Senator GORE. If the design starts in 1958, when would the design be completed?

Mr. DAVIS. The design would probably take something like a year, sir.

Senator GORE. A year?

Mr. DAVIS. Yes.

Senator GORE. Then construction would—I believe Admiral Strauss said earlier today, in referring to the lack of reactors under the 1954 act, that some 3 years in construction would be involved.

Mr. DAVIS. These do not necessarily have to take place in series, though. One starts the design and designs the major components and gets them on order, and starts site work and completes the design in parallel, and not necessarily in series.

Senator GORE. What part of 1958 do you estimate the design will be completed?

Mr. DAVIS. As I say, I do not know precisely when their design will be completed. They have told us it will be started in 1958.

Senator GORE. I understood that the Commission had been on notice that the Pennsylvania Power & Light Co. had not and would not make a firm decision as to the construction of this reactor until certain preliminary tests and experiments had been completed. Thereupon they would make their decision. Am I correctly advised?

Mr. DAVIS. They have stated that they will decide what they will do at such time as they have completed the first phases of the research and development which is underway.

Senator GORE. But this is listed as one of the 18, Mr. Chairman, when the company has not—and you list it as one to be completed in 1962—and yet Dr. Davis has just confirmed the advice I had previously received that the Power & Light Co. had advised the Commission that it had not made the decision yet, and would not make it until certain experiments were completed.

Mr. DAVIS. This reactor is listed on page 55 as one which is being planned, and I believe a company which is spending several million dollars a year of their own money on research and development is quite serious about this project.

Senator GORE. It is a serious matter, there is no question about that. But this is listed as one of the 18 "to come into operation not later than 1962."

Mr. STRAUSS. That is the plan. This company would build a reactor, and we would like to see them build this advanced type.

Senator GORE. So would I.

Mr. STRAUSS. It is certainly not practicable to expect them to say that they will build this advanced type until the type has been demonstrated in a laboratory as a type which will operate.

Senator GORE. Well, I certainly hope that I am not in any way being unpleasant. If I am, I will adjourn here and we will go out and talk about Angus cattle, a matter of mutual interest. I do not wish to be unpleasant, but I do respectfully raise the point that here is listed and here is cited on your statement to the American people a reactor planned to come into operation by 1962, and yet you and your Commission are on notice that the power company involved has not even yet made the decision that it will construct such a reactor.

Mr. STRAUSS. It has made a decision contingent upon the reactor being a feasible reactor. If it should prove not to be a feasible design, you would not expect them to spend the money to construct it. They are spending large sums of their money to prove its feasibility.

Senator GORE. I did not understand Mr. Davis to use the exact words which you have used. My advice was not that the company had made a decision to build it contingent upon certain things, but I understood they had taken the position they would decide what to do after certain experiments had been made.

Mr. STRAUSS. To my mind, there is no difference.

Mr. DAVIS. Could I also add that, of course, this particular reactor hinges fairly heavily on the results of our program at Oak Ridge. As you know, I am sure, we have had some difficulty with that.

Senator GORE. I spent a good portion of half a day climbing all through that reactor last Friday. I think it offers great promise, and for a layman I was greatly impressed with its prospects. I am not sure that that is not the most promising design that is now on the horizon. My opinion would not be worth so much there.

Mr. DAVIS. This is also the opinion of Pennsylvania Power & Light, and Westinghouse, and we have had a number of discussions with them. I think that, although you are quite correct that their public statements said that they were not committed to go ahead regardless of the research and development results, it is quite obvious that they have every intention of doing so if the research program shows that it is a prudent thing to do.

Senator GORE. I think we understand each other there. Will you go to the next one?

Mr. DAVIS. The Florida Power Corp., Florida Power & Light, and Tampa Electric have had underway for the past year or so some studies by severel contractors, and it is our expectation that they will make a proposal to us in the near future under the third round.

Senator GORE. You think that they will?

Mr. DAVIS. I have had discussions with them in which they have told me that they planned to; yes, sir.

Senator GORE. How would they reach 1962, and how would it be completed if they have not even made a decision yet?

Mr. DAVIS. This gives them 5½ years, or 5 years for completion, which I think is adequate.

Senator GORE. Your list shows 1964.

Mr. DAVIS. No; I am sorry, this is the Florida Power, which is 1962.

Senator GORE. I am sorry; this is New England which I had.

The CHAIRMAN. We had an agreement with the witness that at 3 o'clock we would stop the questioning and continue to the next witness. And he has agreed to come back Monday.

Senator GORE. There are only three more in this list, and would it be agreeable for him to complete that, and then I will desist. If that is satisfactory with the committee and with the witness——

Mr. STRAUSS. Certainly.

Mr. DAVIS. New England Electric System—their statement is a statement which was approved by their board of directors as an official company action, that they were planning the inclusion of a reactor of about 200,000 electrictl kilowatts to come on in their system by 1964.

Senator GORE. But they have made no application for license.

Mr. DAVIS. No, and they would not need to do so at this stage.

Senator GORE. All you have on this is a statement by the board that they plan sometime in the future to undertake an atomic-power reactor?

Mr. DAVIS. A statement that they plan at this particular time in the future to do it.

Senator GORE. When is that scheduled to be completed?

Mr. DAVIS. 1964, sir.

Senator GORE. But it is listed in the Chairman's statement as one of those planned to be completed in 1962. That is another slight deviation.

Mr. DAVIS. The Carolina-Virginia Nuclear Power Associates have had a number of discussions with us. They are quite earnest about their project, but they have not yet crystallized it as to the type of reactor and the precise time scale or just exactly how they are going to proceed. But they have formed a corporation, and they have hired

an engineering company, and they are proceeding to go about this in a very earnest and realistic way.

Senator GORE. But they have not decided what kind they will undertake, if they do, and they have made no application for license or construction permit and they have listed no date, and no date by which they might build a reactor; is that correct?

Mr. DAVIS. That is correct, but of course they have to get some people who are experts in to assist them before they can even make some of these decisions.

Senator GORE. I am trying to find out where these 18 are, that are to be in production in 1962, and I have not been able to find them. I would not count that as one of them.

Now, will you go to the last one?

Mr. DAVIS. The Middle South Utilities. We have had discussions with some of their people, and with Dr. Zinn, and they are very much in the same situation as the Carolina-Virginia companies.

Senator GORE. They have issued a press statement.

Mr. DAVIS. And they have hired a responsible engineering firm, and they are proceeding with their plans as rapidly as they can.

Senator GORE. Thank you, Mr. Chairman.

The CHAIRMAN. Thank you very much.

Mr. STRAUSS. Could we go off the record for one moment?

Representative Cole. Could I have an understanding that there is a determination by the Commission members to return? I am frankly disappointed that you have this interruption from the Commission's presentation. I have a number of questions I would like to develop. Unfortunately circumstances do not permit that. When will the Commission be back again?

The CHAIRMAN. I understand, the Commission will return Monday.

Mr. STRAUSS. This is the most important piece of business that the Washington staff has before it. The Commission in the field goes merrily along irrespective of what we do, and it is very important for us to be here and we will come whenever you say.

Representative COLE. I will defer my questions until that time, but I would like to make one or two observations.

As I read the Chairman's summary of the Commission's operations, I was no less than completely astounded by the degree of progress that the Commission has made. I reached that feeling of amazement as I contrasted the situation today and as it is projected into the future, with the situation in 1952 and 1953, before the law was changed.

After the law was changed, it was necessary for the Commission to promulgate its rules and regulations, and to get a staff to carry out these rules and regulations, and at that time industry had not the slightest idea of what was involved in constructing a reactor of any sort. It had to get its personnel, and it had to get its clearances and it had to learn lessons in atomic energy. Now in a space of perhaps 2 year's time, it is no less than completely amazing to hear you tell me that 1 million people, human lives and human beings, have been helped in some fashion by atomic energy. You tell me that in our economy, and in agriculture alone, there are annual savings of $200 million, and in industry $300 million. You tell us that the anticipated program involves expenditures of $750 million of private capital, substantially all of private capital, and tell us in the year 1957, $500

million of private capital for the most part is being spent in that program.

I tell you, Mr. Chairman, my hat is off to you and the other members of the Commission for the truly remarkable progress that has taken place in this field in 2 years' time.

Senator HICKENLOOPER. Mr. Chairman, without taking further time I want to reemphasize what Mr. Cole has said. I have followed this development for a good many years now. At no period in the Commission's existence has greater progress been made than in the last 4 years, and I doubt if as much, toward the beneficial uses of atomic energy and toward genuine constructive development. I join in congratulating you and the rest of the Commission.

Mr. STRAUSS. Thank you, sir.

Senator PASTORE. This past fall or in the month of December, I made a tour of most of our Government installations. I was amazed at the progress that had been made. We are in a very competitive business internationalwise It is true that we are doing a great deal. The thing I question is whether or not other nations are doing more than we are. I do not know whether or not we have any intelligence on the subject or whether we have any factual data on the subject. I say if there is a likelihood that other nations may be getting ahead of us while we take off our hats to private industry and free enterprise and applaud them for all they have done, I think it is a field where Government must assume a proper partnership together with private industry, and if we are not doing enough, we ought to be doing more.

Representative PRICE. I would not take anything away from the progress made in the last 4 years. But all the progress has not been made in the last 4 years. After all, the industrial participation groups were organized before 1953. They were paving the way and setting the groundwork for the present programs. I would not take away from the present Commission credit for progress made since 1953. Neither would I take away from the previous Commissions credit for progress that was made in the initial phases of the industrial program and the pioneering in the field. I think the statement made in the last minute or so relative to industry's financial contribution was not entirely accurate. I cannot recall any figure of $500 million of private participation in this program. However, these are the things that will develop as this hearing progresses.

The CHAIRMAN, With deference to the Chairman, he has been on the stand for 3 hours, and I have sympathy for the witnesses. I felt it in the best interest to ask him to come back, which he has agreed to do. That is why we are taking up the next witness.

Thank you very much.

Mr. STRAUSS. Thank you, Mr. Chairman. Thank you, gentlemen.

The CHAIRMAN. Mr. Murray is the next witness to appear before the committee. Do you have a statement, Mr. Murray?

Mr. MURRAY. Yes, I have, Mr. Chairman. Before reading this prepared statement I should like to make an urgent request of this committee.

The CHAIRMAN. You may do so.

Mr. MURRAY. This relates to Chairman Strauss' request, publicly made this morning, referring to nuclear weapons. You will recall that he asked that your committee afford him an opportunity in execu-

tive session to testify—I think I have the correct quotation—on weapons development, and to deal with several misapprehensions which are now on the record. The issues of weapons policies and development are of such transcendent importance that any misapprehensions concerning them cannot be permitted to remain unresolved. So I accordingly urge that your committee hear the Chairman on this subject as soon as you possibly can.

The CHAIRMAN. We will be glad to, and will do so.

Mr. MURRAY. Mr. Chairman, I appear before your committee today to present my views concerning our present policies and programs for the development of industrial atomic power. I am convinced that they are not adequate. Our policies and programs do not, in fact, accord to the development of industrial atomic power the status it should have as a goal of national importance.

I would prefer to confine my remarks to the development of industrial atomic power. However, this is unavoidable, since the issue of private versus public power is continuously being interjected into the question of power-reactor development. Only last week, for example, one of our leading business magazines focused attention on these hearings with this statement:

> Public versus private development of atomic power is about to break out again as a major national issue.

This and numerous similar statements confuse the main issue. The confusion must be removed. The question of the methods and rate by which industrial atomic power should become available transcends the issue of public versus private power.

I believe that it is absolutely essential that the traditional primary role of private industry in the production of electric power be preserved. I hold, as a matter of principle, that whenever a task can be satisfactorily performed by private industry, the fulfillment of that task ought to be left to private industry. This principle is basic to the American system of free enterprise.

You will recall that recognition of this basic principle caused me to insist that private utilities be given the opportunity to take a major part in supplying the enormous electric-power requirements for our expanding atomic-energy production sites at Portsmouth and Paducah. Before I joined the Commission, practically all our power requirements were met by Government projects. The pattern that I established in 1950 which resulted in the formation of Electric Energy, Inc. (EEI) and the Ohio Valley Electric Corp. (OVEC) is well known. Under these arrangements privately owned utilities are now supplying approximately 3 million kilowatts of electric power which otherwise would have been furnished by Government-financed projects.

Our first consideration in weighing the issues of industrial atomic power should be the national interest. This must be the consideration overriding all others. To understand what this interest is requires a realistic appraisal of this Nation's responsibilities. And by a realistic appraisal I mean one that takes adequate account of the threat posed by nuclear weapons, the potentialities inherent in atomic power, and the promises we have made to nations abroad.

Earlier this month, I reported to your committee in executive session and again directed your attention to the widening dimensions and the nuclear-weapons threat. When viewed in the light of this

worldwide threat alone, the national interest demands the development of atomic electric power on an urgent basis.

It is this urgent need for industrial nuclear power that has caused me repeatedly to insist that our program for power-reactor development be accelerated. This urgent need is likewise the basis for the warnings I have repeatedly given against the Government's prematurely yielding its primary responsibilities in the power-reactor field to private industry.

Private industry is not prepared today to provide more than a portion of the financial support to the power-reactor development program which the national interest requires. We are constantly being told that private industry is ready and willing to assume responsibility for building large power reactors without direct Government support. However, these assurances carry no guaranty as to when such projects will be completed. The experience of the past year gives evidence of this. The schedules given you last year have proved to be overoptimistic. The completion dates for some of the large reactor projects have been set back a year during this period.

No criticism of private industry is intended by these remarks. On the contrary, industry is to be complimented on the financial and manpower contribution it is presently making to the power-reactor effort. The measure of this contribution is not sufficiently appreciated.

There is one factor which I believe is most responsible for detracting from industry's significant contribution. I refer to the widespread and unfortunate tendency to underestimate the intricate and difficult problems involved in the design and construction of large-scale reactors. The fact that several concerns are now engaged in efforts directed toward such construction, despite the barriers, demonstrates the determination of private industry to contribute toward the advancement of industrial atomic power.

However, it is clear to me that industry can hardly be expected to support an effort beyond that required to meet its own needs on its own time schedule. Industry's time schedule is set primarily by this country's needs for electric energy. But the time schedule required by the national interest is much shorter. It is set by the crisis in nuclear weapons and the world need for atomic power. In this connection, the president of one of our largest utility companies said that if the Government believes the public interest requires acceleration of the reactor program, on that basis alone, private utilities have no right to complain.

Senator PASTORE. What is the name of that man?

Mr. MURRAY. That is the president of the Commonwealth Edison Co. It is Mr. Willis Gale.

Senator GORE. Is that a public statement?

Mr. MURRAY. This statement was made before the Atomic Industrial Forum several months ago.

Representative PRICE. It was made in Chicago last fall. Pretty widespread distribution was given to it.

Mr. MURRAY. That is right. However, he added that if acceleration is accomplished in a way which favors public power over private power, then industry does have a right to complain. To this statement I heartily subscribe.

However, some private interests continue to oppose any program of reactor construction financed by the Government in order to accelerate development. I am firmly convinced that it is fear that motivates this opposition. There are some who view private investment in power-reactor projects as insurance against the entry of the Federal Government in this field. This is unrealistic. Such action will never prevent an "atomic TVA."

Let me explain. Public utilities today purchase their conventional plants from the same industrial sources as private utilities. The same will be true of nuclear powerplants, when they are available. The Government or any publicly owned group will be able to buy nuclear powerplants without respect to the origin of their development. It will make little difference whether the development dollars come from industry or from the Government. The extension of Government ownership into the field of atomic power can only be prevented by an electorate informed of the vital necessity of properly controlling the extent of public power.

The effects of this fear of an "atomic TVA" are felt in the Commission's power reactor development program. This program is presently based on the central premise that the Government should restrict its activities to exploring new reactor concepts on a prototype scale—to building small experimental units. It does not distinguish between foreign needs and domestic needs—between short-term goals and long-term goals. It leaves responsibility for designing and constructing large reactors to private industry. However, if we are to get the answers to atomic power quickly, the Government cannot relinquish the responsibility for constructing large-scale reactors during the years immediately ahead. Only by operating large reactors can we hope to obtain the complete information we need to determine what role nuclear power will play in our own economy and that of friendly nations.

Our experience with pressurized water reactors illustrates this dependence on large reactor construction. It demonstrated the limitation on the application of information from small reactors to large units. As far back as 4 years ago we had in operation a successful pressurized water reactor of comparatively small size. This was the land-based prototype for the *Nautilus* at Arco, Idaho. But the experience from this plant was enough to guarantee successful operation of a full-scale pressurized water reactor. This is why, early in 1953, I initiated the steps which resulted in the building of the Shippingport unit. Once again, I acknowledged the debt that this pioneer project owes to your committee. Without your active support it would not have moved forward. The kilowatts from this plant will be the only significant block of nuclear power we will get for the next several years. However, it would take a bold man, even today, to predict the difficulties this unit will encounter before it is capable of supplying reliable electric power. It would take a bolder one to guarantee the costs of power from this nuclear plant.

For example, only 3 years ago it was estimated that construction costs of the reactor portion of the Shippingport reactor would be approximately $37 million. The best estimate today is some $55 million, an increase of about 50 percent. And, if those manufacturers who suffered losses in supplying certain parts for this project were

reimbursed and allowed a normal profit, the presently estimated cost of $55 million would be even higher.

Evidence that actual construction costs will exceed original estimates is available for many other projects. The sodium graphite reactor project for the Consumers Public Power District, first estimated at around $25 million for the entire plant, has now about doubled. In order to keep this important project going it became evident to me that the Government would itself have to take over construction of the reactor portion of this project. Recognizing this, I urged last year in a statement before your committee that the Government assume responsibility for constructing this reactor. Subsequently, the Commission decided to adopt such an approach and contract negotiations are now proceeding on this basis.

This tendency to underestimate costs is not confined to large reactor projects. Construction cost estimates for the 10,000-kilowatt nuclear powerplant of the Wolverine Electric Cooperative have already increased about 25 percent. The original estimate for the Rural Electric Power Cooperative plant was withdrawn. It is now known that costs for this project will be substantially higher than anticipated at the outset.

There is some evidence that private industry is becoming increasingly aware that there has been too much salesmanship and not enough engineering in nuclear power. Industry is beginning to learn that nuclear power involves large costs and that these costs will increase. Those aware of these facts have come to the view that it is premature today to believe that the economic merit of power reactors can be evaluated realistically.

As this understanding becomes more widespread it should lead private industry generally to welcome the assistance that a Government program of large reactor construction can give in the immediate years ahead. Such an effort would give industry the initial information and data so necessary in its attempts to bring its own announced projects to completion. It would help reduce costs. More importantly, it would substantially lessen the risk that private industry's plants will fail.

However, there is even a more vital need for an accelerated power-reactor program than these benefits that would enure to private industry. Unless we undertake a program of large reactor construction today, our progress in the years immediately ahead will be unacceptably slow. Unless this is done industrial atomic power will not be developed soon enough to enable us to meet our responsibilities as a Nation.

This situation has been apparent for several years. We have long recognized that Europe would soon be faced with a serious power shortage. It was evident that nuclear power would be necessary to meet this shortage. Moreover, it should have been apparent to those familiar with the European situation that a failure to meet this need would have serious consequences for the economy of western Europe. I urged a policy which would help to meet this situation. You will recall that I recommended in mid-1955 that this country take steps to prepare itself to provide the reactor equipment necessary to meet a demand for a million kilowatts abroaod by 1961. Yet

some labeled this proposal a crash program—others called it a kilowatt race.

Kilowatt race or not, the need for such a policy was brought into sharp focus by the recently announced objectives of the European Atomic Energy Community (EURATOM). These objectives include 3 million kilowatts by 1963 and 15 million kilowatts by 1967. The magnitude of the 3 million kilowatt goal is indicated by the fact that it would take 30 Shippingport reactors to meet it. However, as a result of the policies we have pursued, the state of our reactor industry permits us to render but limited assistance to EURATOM in its attempt to reach these goals. We certainly could have been better prepared to meet them.

It could turn out that Britain will be better prepared to satisfy EURATOM's needs than we. Progress in Britain during the past year suggests this. It is reported that improved designs of the original gas-cooled Calder Hall reactor will be capable of operating at power levels considerably above the original design. I am informed that the United Kingdom authorities are now convinced that the gas-cooled reactor is the answer to their own power problems. I understand further that they are now making plans to build from 30 to 40 large power reactors on the basis of their success with the gas-cooled type. These are to be directed primarily toward the production of power. But it is only as a result of having built and operated a large reactor that they can now confidently predict that their own increasing power requirements can be met. They would not have been able to make the decision to expand their program had they limited themselves to constructing small prototypes.

Another region in which we are in danger of losing our prestige in the power-reactor field is Japan. It has been reported that the Japanese are seriously considering the purchase from the British of a power reactor similar to the Calder Hall type for the first large installation. This could have been avoided. I suggested one way in 1954. At that time I recommended that we build a power reactor of the pressurized water reactor type in Japan. A Commission study of this proposal recognized that such a project could be carried out. It seemed to me that this would have been both a Christian gesture and a means of maintaining our prestige in the power reactor field.

This brings me to my recommendations. Before presenting them, however, it may be helpful to repeat the two phase into which I divide reactor development, namely, the short-term phase and the long-term one. During the first phase, that is, the period immediately ahead, the Government should concentrate on the construction of the reactor types that we presently feel confident can be made to operate successfully as large-scale projects during this period. The primary responsibility for building these large-scale reactors during this period should be with the Government. During the second phase, it is my hope that the burden for meeting our Nation's responsibilities will be assumed by private industry.

First on the list of the reactors that the Government should construct in the earlier phase is one I suggested a year ago—a large-scale gas-cooled reactor. There may be considerable reluctance to our undertaking such construction. Many will maintain that by the mere interchange of information under our power bilateral agreement

with the United Kingdom, the Commission and American industry will be given all the information they need to evaluate the ultimate place that this type of reactor will play in the industrial power reactor field. As a consequence they would not feel actual design and construction necessary. I am convinced that such information alone would not be sufficient. Moreover, I am convinced that our scientists and engineers can improve on existing gas-cooled reactors. The result might well be that the gas-cooled approach could become one of the keystones of the industrial use of atomic energy. This possibility explains the priority that I suggest we give to the building of a large-scale gas-cooled reactor.

Another variant of the natural uranium fueled reactor is the one cited as ready for large-scale construction in the Commission's announcement of the third round under the power demonstration reactor program. I refer to the natural uranium-fueled heavy-water type moderated reactor. This is another type that should be constructed during the first phase outlined above.

A third reactor that should be constructed in this early phase is an enlarged and an improved version of the pressurized water reactor now being completed at Shippingport. All the valuable lessons that have been learned and the extensive experience acquired in the course of developing and constructing this plant would be incorporated. An expansion of this effort is necessary if the United States is to capitalize on its progress in the pressurized water field. Such a plant would permit us to accelerate the testing of new-core concepts, reactor-system components, and new-design factors. It would enable us more rapidly to determine the role that the pressurized water reactor will play in the future of the atomic-energy industry.

Among the large reactors I recommended for construction a year ago was the sodium-graphite reactor. The need for large-scale construction of this type should be met as a result of the Commission's decision that the Government will assume responsibility for constructing the reactor portion of the plant for the Consumers Public Power District.

Although a year ago I also recommended construction of a large-scale homogeneous reactor, I now group this with reactors to come into operation in the second phase. The technology of this design is not as far advanced as the three that I have recommended.

The location of these first reactors is an important consideration. Repeating my recommendation of last year, I again suggest that they be placed at the sites of our production facilities so as to eliminate as far as possible the issue of public versus private power. Electric power requirements to meet production needs are so large that they could easily absorb the output of these reactors. Moreover, at these locations it would be possible to carry out experimental operation without affecting production of weapons material.

This program of large reactor construction should be in addition to efforts under the power demonstration reactor program, including the third round. I recognize that efforts under this program will make a contribution to the larger program that I believe necessary. I have continued to endorse them on that basis.

In conclusion I urge once again that in weighing these remarks concerning the development of industrial atomic power you keep in

mind the mounting threat of nuclear weapons and the growing world needs for atomic power. Each is related to the other. In the last analysis our policies and programs for the development of industrial atomic power will enhance our security in proportion as they take account of the weapons threat and the world power shortage.

It would be a tragic mistake to take any lesser view of the issues at stake in the development of industrial atomic power. Our vision must surely penetrate beyond the restricted view that measures the national interest in terms of our own domestic energy needs. It should also rise above the issue of private versus public power.

Only by taking this larger view can we hope to fulfill this Nation's responsibilities for atomic power development. Only in this way can we justify before God our stewardship of the atom, which can become the richest of his material blessings.

The CHAIRMAN. Thank you very much, Mr. Murray. I believe in your statement here you recommend three different types of reactors. Is that correct?

Mr. MURRAY. It is, Mr. Chairman; yes, sir.

The CHAIRMAN. Did you make any estimate of the cost of these three types of reactors?

Mr. MURRAY. I did.

The CHAIRMAN. Would you mind giving it to us?

Mr. MURRAY. I can give you approximate figures. The figures that I recommended to the Commission some time ago would be broken down into research and development and construction. The figure amounts to approximately $300 million.

The CHAIRMAN. That would produce how much in the way of kilowatts?

Mr. MURRAY. It would produce anywhere from 600,000 kilowatts—I should say from 400,000 to 500,000 kilowatts.

The CHAIRMAN. Senator Pastore.

Senator PASTORE. I would merely say this, Mr. Murray, that I think this joins the issue. I think this in very clear language expresses what many of us have been trying to say. It points up the divergent points of view on this subject. I think you said it very, very clearly here that what we need to do is to build several large-scale reactors. The thing that impresses me very much is this argument that you have made on this gas-cooled reactor. If I remember correctly my distinguished colleague here from Tennessee made a trip last fall, I think, to Japan, and was told there by the people interested in the purchase of this reactor in Japan that they were very much interested in this Calder Hall type. Right there internationalwise it looks like we have lost a little business. We have not a gas-cooled reactor in this country.

The argument has been made here that it is not wise to build these large-scale reactors, that we should build prototypes in order to do the research and development. The argument that you have made in your presentation here this afternoon is that we ought to get on the way and build these large-scale reactors.

You say we ought to build them on Government sites. What is wrong with building them as we built the Shippingport reactor?

Mr. MURRAY. There is nothing wrong. There is no trouble in my mind in building types according to the Shippingport design.

Senator PASTORE. I am not talking about the design.

Mr. MURRAY. I do not mean design, but the program of the Government building the reactor and the private utility building the powerplant; there is no difficulty in my mind about that. At the present time, of course, the present law would prevent you in a way from doing that, except that you gave the first option to purchase that power that was produced to cooperatives and to public power groups.

Senator GORE. The preference clause, you mean?

Mr. MURRAY. Yes. The point, of course, Senator Pastore, is that we do something. If we take a look at the Yankee pressurized water reactor——

Senator PASTORE. I was going to bring that up.

Mr. MURRAY. I thought maybe you would. Let us take a look at that. We should evaluate that. That should be an advanced PWR reactor. They have done a lot of work in that field. They have spent a lot of money. They have put in a lot of effort. It might well be that in order to get that job done and be sure that it will be done by 1960 or 1961 or 1962, we get behind that project. That we convert that particular job into a Shippingport job. I do not know that the Yankee group would even consider that. I have never explored it. I have an open mind, in order to get on with this job. We did this with Consumers' job, as I indicated here. They got into trouble. Costs went up. They could not get any guaranty on costs. The Commission decided that this was an important avenue to explore, and we moved in and we took over. We may find once policy was settled, as I was trying to explain here, on an early phase and a second phase operation, that this is the way to get on with the business. How you divide them, where you put them is perhaps in the lap of the gods, but I feel that the suggestion that we place them at our production sites is at least one solution, and a practical one, to get these things done.

Senator PASTORE. Is it your idea that the other Commissioners disagree with you on your viewpoint? I do not mean to get into personalities now. It would not be pertinent in any way.

Mr. MURRAY. There is no question of personalities here. It is just a question of time schedule. How soon do you want to get the answers? It is entirely a time schedule. If we have plenty of time to develop atomic power, what we are doing under the first, second and third rounds is perfectly legitimate. It is perfectly all right. It follows the private industry pattern which I am heartily in favor of. But there are other considerations that come in. There are other commitments that we have around the world. We have prestige to maintain. At least I think so. I am trying to suggest here a way to get on with being in a position to meet the demands of friendly nations, and at the same time perhaps come up with some good answers to economic power in this country.

Senator PASTORE. You will admit that private industry has made a considerable investment in this enterprise since the law was passed in 1954.

Mr. MURRAY. I could not underemphasize that.

Senator PASTORE. You are equally convinced it is not quite enough.

Mr. MURRAY. It is not enough. I recognize their approach. Their time schedules are different. What differences does it make to the Yankee Electric Power Co. whether they come in in 1961, 1962, or 1963?

Senator PASTORE. If they really do not need the power.

Mr. MURRAY. There is no incentive. There is no drive. I do not want to in any way indicate that these dates that we were given a year ago were not the best judgment known at that time. I was trying to point out that this is a different kind of business we are in. We are in a business where we are exploring new areas. We are in a business where you get into the millions of dollars. I cannot for the life of me see how private industry is going to meet this problem on any sort of short-time schedule.

Senator PASTORE. What was your reaction to the optimism of the EURATOM representatives in reaching their goal of 3 million and then 15 million kilowatts?

Mr. MURRAY. Personally my face was red when they presented such a proposal. It was red because as I said here, maybe we have oversold atomic power. Why did these three wise men come from abroad to this country to ask us for 15 million kilowatts of atomic power in the state of the atomic industry as it is today?

I did not mind meeting them. They were a very nice group. We talked very generally, and said we would like to cooperate. There was a statement that was put out, "Fine, your objectives are good. Let us get on with the job and we will be of all the assistance we can to you." We will. We will do everything we can.

Senator PASTORE. I was in Argonne in December and they took me to the boiling water reactor, and that is 5,000 kilowatts, and that was going to go critical within a week's time, and they thought they had hit the jackpot. So when these people talk about 15 million kilowatts, I, too, was somewhat flabbergaster, and I wondered where they got the brilliant idea of producing these.

Mr. MURRAY. They might have said 50 million kilowatts. I don't know where they reached this 15 million. They looked at the economy of Europe and all the other features involved in supplying power for the European nations, and they have come up with the conclusion that they need this. They have put goals and time schedules on. They themselves, Senator Pastore, indicated they did not want the last word in reactors. They were going to divide their program into what they could get between now and 1962, and then hope that after 1962 they would get better ones.

Senator PASTORE. I merely want to say this, and I say this for the benefit of all the Commissioners and all of the staff who are interested in this problem, as well as we are. This is precisely as I feel about this whole business of getting on with this reactor campaign. After all, it has become an integral part of our foreign policy. There is not a presentation that is made before this committee, there is not a speech made before the United Nations, that we do not speak in glowing terms—and I agree with it myself—about this very electrifying speech that was made by the President of the United States on December 8, 1953, when he addressed himself to the United Nations at the General Assembly, speaking of this international agency, and this international cooperation of Atoms for Peace. I have said a hundred times here it has become almost a cliche, what are we going to do with this uranium 235—40,000 kilograms of uranium 235, if we do not have the reactors to burn it in? It strikes me not so much that it is the criticism of private industry—I think private industry is doing a fine job, but there are limitations upon it—now here comes Mr. Murray,

a member of the Commission, who has lived with it for years, and he says we can build these large-scale reactors.

From now on, I would like to have the members of the Commission and the members of the staff prove where Mr. Murray is wrong, because in doing that, I think they will prove that some of the ideas that I have on this subject are wrong. I have been saying right along that what we ought to do is to build a number of large scale reactors. Here comes a member of the Commission and tells us that can be done. I think the Commission ought to come forward and prove where Mr. Murray is wrong. Then you would prove why we should not have passed the Gore-Holifield bill.

Representative HOLIFIELD. Mr. Chairman, I want to aline myself with the statement that Mr. Murray has made and with the remarks that Senator Pastore has made. There is one qualifying question that I would like to go into whenever time affords, and I will not take my colleague's time on the committee at this time, and that is, the type of negotiations with the Consumers Public Power District, what type of arrangement is considered there. I would like to have that explained.

In general the statement which Mr. Murray has made states exactly the way I feel about it. I would like to see this program advanced, and I would like to see the public versus private power element completely kept out of the project, if it is possible, as Mr. Murray speaks, and I believe it is possible. I would like to see us get on with the job.

The CHAIRMAN. Senator Jackson.

Senator JACKSON. There has been so much discussion, Mr. Murray, on this question of private utilities or the Government building power reactors, that I think it is getting very confusing, indeed. I should like to ask a couple of questions.

Why should a private utility build a large scale power reactor at the present state of the atomic reactor art, assuming that the head of that company is a good, sound private utility executive, interested in bringing a good return to his company and to provide power at reasonable rates based on a sound investment?

Mr. MURRAY. I have given you one inkling of what I think motivates the various moves of the private utility companies. It is a fear. As of today, I do not see any reason.

Senator JACKSON. If I were a stockholder in a private utility company, and had a lot of stock in it, I would insist that such an executive be fired. Is that not right? He is supposed to try to provide power at low cost. If he understakes a project charged with the responsibility of making a fair and reasonable return in accordance with State regulations, is not he a poor manager as far as the owners of that company are concerned?

Mr. MURRAY. I know you will excuse me from answering that particular question in that way.

Senator JACKSON. I'm concerned with the commonsense of the matter.

Mr. MURRAY. This is the first incident in my experience in public utilities, and I go back and my father goes back to private utilities, back in the 1890's—that public utility companies as such have gotten into the manufacturing business in a way. This is a new tack that has been taken here. It is a combination of public utility companies in order to do a job, which I think primarily belongs in the manufacturers' laps.

Senator JACKSON. What I am trying to say is this: Do you think that consumers of electric power should pay for the added cost? How would the XYZ company explain raising rates to a fabricating company that takes a lot of power, and the ABC company in adjoining areas not raising rates because they are using conventional fuels? They would say in the XYZ company, "We are going to bear part of the cost of the atomic energy effort in research and development, and the ABC company is not patriotic enough, they are not going to pass the costs on to their consumers." Is that the line of reasoning?

Mr. MURRAY. No. I think the utility companies might very well tell you that they are looking always ahead 5, 10, 20 years, to try to get better production facilities, to try to get better everything.

Senator JACKSON. At a lower cost. It is not to have a better plant. Everything is cost, is it not?

Mr. MURRAY. It is at the moment.

Senator JACKSON. I am not deprecating the private utilities. I am trying to ask the questions that I hope go to the heart of the problem.

Mr. MURRAY. I have been trying to ask myself these same questions.

Representative HOLIFIELD. Will the gentleman yield on that point? Is not that same logic applicable to these cooperatives that are jumping into a deal that they do not know a thing about, and that is going to cost their consumers additional money, too?

Senator JACKSON. It applies with equal force to anyone who has to sell power to the consuming public. That includes the housewife who wants the power for household use, and to the company, large or small, to whom the cost of power is an indispensable item in the product.

Doesn't it really boil down to this, that the private utilities feel that if the government goes into large scale reactors, then the Government is in the public power business, and they are going to be squeezed out through unfair competition? Isn't that essentially it?

Mr. MURRAY. I think that is one of the motivating factors to lead them to do what they are now doing.

Senator JACKSON. If large scale reactors are necessary from the standpoint of the technology that we must acquire, and if large scale reactors are necessary for the prestige of the United States in the light of our many commitments abroad, it seems to me that we should go forward with a large scale program. Is that the way you feel?

Mr. MURRAY. I agree with that. I know, Senator, you are not forgeting, as you so well know, what the world is up against today in this nuclear weapons threat and nuclear annihilation. Anything we can do in this direction, anything we can project to get nuclear materials used for peacetime purposes is a great move forward. That is why I think the President made a splendid contribution to that when he said "I will assign so many thousand kilograms for the peaceful uses of the atom."

Senator JACKSON. I certainly agree with you, Mr. Murray. I think the President's speech was a great contribution to better relations, particularly in many of the uncommitted areas of the world. It would seem to me that what we really should be doing is trying to draft some legislation to bring about the construction of large scale

reactors in which the Government can assume the risk, and at the same time protect the interests of the private utilities and the public utilities. I do not see how it is fair for Congress to expect private utilities or public utilities to undertake this risk and this cost.

That is my opinion. I have listened year after year to these arguments, and I think if we are honest with ourselves and honest with the American people, we will admit that a substantial risk is involved which no manager of a large private utility would want to undertake on behalf of his stockholders nor a public utility on behalf of the citizens who are part of that public body.

Senator PASTORE. Will the Senator yield?

Senator JACKSON. Yes.

Senator PASTORE. There is a school of thought, however, Mr. Murray, to the effect that the way to get the job done is not by building large scale reactors, but by building small scale prototypes and spending more money in research and development. You recognize that there is that school of thought?

Mr. MURRAY. Yes, sir.

Senator PASTORE. What is your answer to that?

Mr. MURRAY. I tried to give you one answer here by the illustration of the pressurized water reactor. We had a pretty good sized pressurized water reactor at Arco. The particular kilowatts is classified. But it was in a small range. As I indicated here, you would never know whether you could scale that thing up 5, 6, or 7 times until you actually tried to do it. In just one trip to Shippingport—I was out there 2 or 3 weeks ago—it will give you some idea of what is involved engineeringwise to scale that Arco plant—it is not the exact thing, but the general principles—up 5 or 6 times. It is a new business. We do not know what the scaling problems are. So I also indicated here that Calder Hall would not be able to make the statements—or the United Kingdom would not be able to make the statements they are now making—and project programs of 30 or 40 new gas-cooled reactors to meet their power requirements, unless they had built something of a substantial size.

Senator PASTORE. Have these discussions ever taken place in the Commission?

Mr. MURRAY. I think the Commission generally recognizes that our program is a program to develop new designs, new types, explore avenues that we think are promising. Just in that connection we may be exploring too many avenues. You can get to the point that each salesman that comes in with a new idea you might say, I think that will contribute to the nuclear answer here. You can get yourself in a position that you are backing too many projects. I am not raising that question here at this moment, but I am trying to divide our thinking into two phases here. One is what we can do today and what we are fairly sure we can do, and get on with that phase of it, and see where this power situation leads.

Senator PASTORE. I repeat again, I do hope that the other members of the Commission will attack specifically the proposals made by Mr. Murray in order to disabuse me of some mistaken ideas if I am mistaken in agreeing with Mr. Murray.

Representative PRICE. Mr. Chairman, I want to say that I concur almost 100 percent in the statement Mr. Murray has made here this afternoon. I want to compliment him on the statement. It is a most

refreshing statement from a member of the Commission. It reflects in many instances my own views on this subject. Particularly one paragraph reflects my view. There has been much said this afternoon about progress made in the reactor-development program and other fields of atomic energy. We all recognize that some progress has been made. I do not think we should concern ourselves so much about the progress that has been made, but the rate of progress. I think that is the significant thing. I think the danger involved in the Commission yielding the primary responsibility for the power-reactor program to private industry is that we may fall behind in the development of a reactor for the generation of electrical energy. I subscribe 100 percent to Mr. Murray's general statement, and I subscribe 1,000 percent to this one paragraph on page 3 in which Mr. Murray stated:

It is this urgent need for industrial nuclear power that has caused me repeatedly to insist that our program for power-reactor development be accelerated. This urgent need is likewise the basis for the warning that I have repeatedly given against the Government's prematurely yielding its primary responsibilities in the power-reactor field to private industry.

I certainly subscribe most wholeheartedly to that position on the part of Mr. Murray. It is important for the United States to lead the world in development of electrical energy through nuclear power or is it not? If it is, I think we should be doing more about it.

The CHAIRMAN. Senator Dworshak.

Senator DWORSHAK. I have just one question, Mr. Murray. In your statement you stressed the vital need of accelerating the devolpment of nuclear power, and then you said, "Our first consideration in weighing the issues of industrial atomic power should be the national interest." Continuing you say, "And by a realistic appraisal, I mean one that takes adequate account of the threat posed by nuclear weapons, the potentialities inherent in atomic power and the promises we have made to nations abroad."

Can you be specific in telling us what you mean by promises which have been made to nations abroad?

Mr. MURRAY. I think maybe if I were rewriting that I might put a different word in for "promises." I might change that, Senator, to indications of what foreign nations might expect from us. I have no information to substantiate that we made any very definite promises except as the President has indicated that are now in a position to supply fuel for reactors when they are developed and carried forward. I think, however, you get that by osmosis, through newspapers and everything, that the friendly people abroad are looking to us. I know I personally have not made any promises but I would like to make some.

Senator DWORSHAK. Certainly I can agree with you that we should be fully alerted to the need of making the necessary progress to take care of our national interests. But I question whether the Government or the Congress has any responsibility to provide atomic energy for nations abroad. I think that we can well rationalize and justify greater progress here in the development of nuclear energy, but certainly not because we have any farflung responsibilities to take care of foreign countries in this regard.

Mr. MURRAY. Maybe you might, with one exception, go along with this. In 1954, I took a little different view of that in regard to Japan. I thought that was the first nation that was seared with the atomic

bomb, and so on, and I thought that would have been a Christian gesture and a right thing to do. The need for power in Japan was urgent. I would have been heartily in favor of building that reactor with our funds and resources and getting something underway in Japan at that time.

Senator DWORSHAK. I do not know very much about the details of the atoms-for-peace program, but I do not know why that should be regulated or governed by these demands abroad. I do agree with you that there is a reasonable question whether we are accelerating this program at home. I had in mind asking the question that Senator Jackson did concerning the profit motive which acuates private industry to a large extent. So long as the cost of atomic power is far in excess of conventional power, then I wonder whether we are justified in placing any great reliance upon the cooperation which we might expect from private industry. You realize that, too, do you not?

Mr. MURRAY. Yes.

Senator DWORSHAK. In this viewpoint that you presented to the committee?

Mr. MURRAY. I do, Senator.

Senator DWORSHAK. That the element of private power is involved to a great extent.

Mr. MURRAY. Absolutely; yes.

The CHAIRMAN. Mr. Cole.

Representative COLE. I have only one question, Mr. Chairman. In listening to Mr. Murray's statement, and the discussion which it has invited, it appears that in his view, and in the view of many others, one of the large stumbling blocks in the road toward accomplishing Mr. Murray's recommendations is the public versus private power controversy. Private capital entertains grave apprehensions in that regard, as many of those who oppose the program of Mr. Murray entertain the same apprehensions. If public versus private power is a factor for deterring the accomplishment of Mr. Murray's objective, I wonder what his viewpoint is with respect to eliminating the preference clause of the act with respect to these reactors he now recommends be inaugurated and constructed by the Government? Whether first that would remove to a large degree this fear and apprehension which I call a roadblock. What would be your recommendation in that regard? I ask that since he has said that in his view it is a controversy, that issue should not be involved in the program.

Mr. MURRAY. Mr. Cole, I think the figures between the generation of power by public groups in this country and private groups is about in the relationship of 80 percent to 20 percent. You might well consider handling a large reactor program, if you decided that it should not be placed at our production sites—that was just one method of doing the job—you might find a formula that would satisfy both sides of this issue.

Representative COLE. Can you suggest what that formula would be which would satisfy both sides?

Mr. MURRAY. I used this 80–20 percent division.

Representative COLE. Then if I understand you suggest as a possible formula the allocation of whatever power these big reactors might generate to have 20 percent available for preference requirements, and the balance to the highest bidder.

Mr. MURRAY. I do not know how you would work it out. I just do not want to suggest here anything in the form of legislation until everybody has had a good chance to think it out. You might possibly come to some kind of a formula that might make sense. The Consumers Power project—we have not entered into final contracts with them—is an indication that we have no hesitancy to back a public power group. They came in and they wanted to have a sodium graphite reactor, and the Commission welcomed their coming in. So we handled that situation just that way.

Representative COLE. Have you been as generous with private proposals as you are now considering to be with the Consumers group?

Mr. MURRAY. I think the law would prevent us from doing it.

Representative COLE. If it prevents you from doing it on one hand, it would prevent you from doing it on the other.

Mr. MURRAY. No. The preference clause would not come into play there.

Representative COLE. It does apply to Consumers Power because they get it all.

Mr. MURRAY. You remember the difficulty we had with the General Electric Co. that we had 10,000 or 12,000 kilowatts that we had available there that we did not want to dump into the river. The preference clause gave us a great deal of trouble. That has been settled. The minute you generate electricity from one of these publicly financed reactors, the law tells you that you must give preference, as you know, Mr. Cole, to public bodies.

Representative COLE. In order to conclude, if as you say—and I agree with you largely that this public versus private is one of the big issues which stands in the way—it would seem to me that you and the other Commissioners might well give some thought to devising a formula which would be fair to both contestants so as to eliminate, so far as possible, that issue.

Mr. MURRAY. I think we all have it in mind, and maybe we could come up with something that would satisfy both sides in order not to delay this business of getting on with these initial big reactors.

The CHAIRMAN. That is exactly what we have done in the growth of this whole industry. The element of research and development has been, in this matter, all the way through, both by Government and private industry cooperating to the fullest extent. Is that not correct, in your opinion?

Mr. MURRAY. I think that is correct, Mr. Chairman.

The CHAIRMAN. Probably that is one of the elements in our whole economic life that has contributed more to keep us in the prosperity period that we are in today, in my opinion. I do not see why this thing cannot be done on the same basis, and not get into this controversy of public and private power. I do not see the point, because we have operated precisely like that in bringing us to the point of all this development that we see here today.

Senator GORE. I want to revert to the statement of Senator Dworshak. Whether we agree or do not agree fully with the national policy of atoms for peace—and I happen to agree with it——

Mr. MURRAY. I do, too.

Senator GORE. It is a national policy of high priority. Perhaps President Eisenhower has taken no act and made no statement during his administration which has met with such worldwide acclaim and

national acclaim as his atoms for peace speech to which Senator Pastore has already referred. But we are left presently with a national policy of high priority, but no Government program to implement it, and give it effect and meaning.

Mr. MURRAY. I agree with that.

Senator GORE. You have not criticized private industry and private enterprise in your statement.

Mr. MURRAY. I hope not. I have been trying to do my best to get on the side of private industry because I have been there all my life. At my age, it is going to be pretty hard to get me over on the other side.

Senator GORE. I am sorry that I have not been there to the extent and as profitably as you have, but I challenge anyone to find anywhere in this long fight where I have criticized private enterprise for being slow in entering this risky field.

Mr. MURRAY. I have never heard you say so.

Senator GORE. I think private American companies are but prudent in being cautious in building large-scale reactors. After all, the profit motive is activated by reasonable expectation of profits. The Shippingport power is going to cost what?

Mr. MURRAY. I said it would take a bold man to predict what that power is going to cost. I would rather refer it to Dr. Davis.

Mr. DAVIS. We have not made any new estimate since we got the changed cost of the project.

Senator GORE. What was your old estimate?

Mr. DAVIS. For the first core it was about 50 mills.

Senator GORE. And now you have a greatly increased estimated cost. How could any private concern, Mr. Murray, as one eminent in the field, generate electricity at a cost of 50 mills or 75 mills and make money selling it at 8 mills? How would that activate the profit motive?

Mr. MURRAY. I think the question answers itself.

Senator GORE. I do, too. Here we have a national policy but no means of implementing it except a sole dependence upon the profit motive in a field where profits are nowhere in immediate prospect.

Mr. MURRAY. I think that is correct.

Senator GORE. I have just one other question and then I will not take the committee's time further.

I have become increasingly concerned with the dangers of radiation, radioactive fallout and radioactive waste from a vast development of reactors. Were I considering the problem of reactors alone from the standpoint of the United States, I would not be greatly disturbed, because we do have lots of coal, oil, and gas. I would think we should proceed with development. But I would not feel it is as pressing as it is were it not for the developments coming in other countries. I think it is to the interest of the United States to develop large scale reactors in order, for one thing, to develop safe ways of generating electricity by atomic energy. Apparently Europe is not going to wait for the United States to develop safe ways in which to do it. Apparently Japan is not. In fact, the Chairman of the Atomic Energy Commission over there told me quite frankly that they could not wait 5 years for the United States to complete its so-called experiment, research, and development program.

Am I disturbed unduly about that, or would it be to the interest of the humanity of the world as well as to the United States to develop safe ways in which to generate atomic power and thus make that available to the humanity of the world?

Mr. MURRAY. I would not go as far as that, that you would have to build large scale reactors in order to get these answers how you will handle radioactive waste. I am firmly convinced that problem will be solved. We are making great progress in that direction. I do not anticipate any radiation problems—I was going to say whatever—but there will be some from these spent fuel elements and the effluents going into our various rivers and contaminating that. I believe we will handle that situation, and we have the ability to do it.

Senator GORE. Mr. Murray, what about the possibility, remote or less remote, of a reactor going wild and erupting from its shell? What is the danger to the people in that area?

Mr. MURRAY. That is the risk you would take. Some reactors are more hazardous than others.

Senator GORE. Is it not a risk?

Mr. MURRAY. There is a risk there, but that word "calculated" risk is a risk that I think we should take.

Senator GORE. I was told only a few days ago by people whose opinion I respect that a rupture of a large scale civilian reactor would be equal in calamity to a major event of a major war such as the obliteration of Munich.

Mr. MURRAY. I do not know what that particular person is referring to, but I do not believe so.

The CHAIRMAN. I might say that the committee intends to go into that thoroughly.

Senator GORE. That is fine. I was wondering if this should not be one more reason why the United States should proceed with the development of reactors to provide the maximum safety in this regard.

Mr. MURRAY. There is no doubt about it. Every reactor you build will help you and give you better and new answers to the safety problem.

Senator GORE. Thank you, Mr. Chairman. I wish to congratulate you upon a very lucid and fine statement.

Mr. MURRAY. Thank you very much, Senator.

Representative HOLIFIELD. Mr. Murray, I had one reservation on your presentation, and I would like to explore it because this is the first time it has been called to my attention, although no doubt the staff has been informed of it. There are 2 places in your presentation, on page 8 and page 14, where you referred to the Commission constructing the reactor portion of the plant for the Consumers Public Power District in Nebraska. The question I would like to ask you is this: Under what conditions under the present law could you build a reactor for the Nebraska Public Power people?

Mr. MURRAY. Could I ask Dr. Davis to tell you how that is going to work out? I do not want to make a mistake in the detail. We have some plan worked out that will be all right under the present law.

Representative HOLIFIELD. Would it be the same as the Shippingport formula?

Mr. MURRAY. I think practically.

Mr. FIELDS. It is very close to that formula.

Mr. MURRAY. It is very close to the Shippingport formula.

Representative HOLIFIELD. Would that involve the Government owning the reactor?

Mr. MURRAY. Yes, sir.

Representative HOLIFIELD. Would it involve a participation in the reactor cost the same as the Duquesne Light & Power, I think, participated?

Mr. FIELDS. The actual arrangements in this respect are still under negotiation.

Mr. MURRAY. Duquesne contributed $5 million.

Mr. FIELDS. It will not come out exactly the same.

Representative HOLIFIELD. I was not concerned with the specific amount as I was the general formula under which you are working.

This is a point where I want to sound a note of warning. I have taken the position that Mr. Murray has taken, that this thing can be worked out without this public versus private power fight. I would say if you start taking away from private industry any of their prerogatives or their statutory benefits, or if you start taking away from public bodies their statutory benefits—in this case I am speaking of the preference clause—right away you are going to precipitate this fight. This is one of the things that I would like to stay away from. I recognize the fact that if you do furnish the public power group in Nebraska on very much the same formula as you are furnishing the Duquesne people thermal kilowatts, or the equivalent, that you would have a parallel situation and a situation with a precedent. But I would much prefer to see the development go along the lines that Mr. Murray has outlined, which is the development of these large-scale Government-funded reactors on Government installations where we are now using a great deal of energy, and thereby release both public power, which is being served, such as in the Tennessee Valley, and the private furnished by EEI and OVEC to the civilian communities around. As I understand, there is a need for it in those communities. I think you should proceed with real care in this public power problem here in Nebraska. You are liable to precipitate this fight there again. We saw the fight on the West Milton power. It was an insignificant amount of power. Yet the feeling came up on that.

Another reason why I favor Mr. Murray's original formula here of building reactors on Government atomic energy sites would be that the maximum benefit to be obtained out of operating these large reactors might involve intermittent use, changing of cores, or introduction of improvements, during a time when power would have to be supplied from another source. If you did not have the right to have these interruptions of power in the large reactors, I think you might face a lessening of the Government's benefits from an experimental reactor of a large size.

Mr. MURRAY. I do not think you could dare take a chance placing any of these very large 100,000 or 200,000 kilowatts except on some large system that could absorb it while it was shut down for a period, until you knew you could get firm power.

Representative HOLIFIELD. This is why I view with some degree of concern the proposal here to build a supply source for the Consumers Public Power District. Because if they are depending on that source to be a firm and continuous source, you are going to deny the Government the benefit of an interruption in their own reactor. The public obligation to serve these people might be then to the point you might lose some of the benefit which the Government might get out of an experimental large type reactor.

Mr. MURRAY. I do not know what proportion that 40,000 or so kilowatts is in relation to their total load.

Representative HOLIFIELD. I do not, either.

Mr. MURRAY. And their ability to buy fringe power from other places. I think they recognize that it will be maybe some years after we get going that they can really depend on this 40,000 kilowatts.

Representative HOLIFIELD. In the case of the Duquesne thermal units, you are in a position there where you can interrupt the Government operation of the reactor, and there are other lines that can take over.

Mr. MURRAY. Ours is such a very small proportion of their overall load that I cannot see it would make very much difference.

Representative HOLIFIELD. If we are going to keep out of this public versus private power fight which I think we all want to keep out of in the interest of getting a job done and building efficient reactors, I think some of these prospects ought to be thought of pretty carefully before we jump into it, and then use it as a precedent for something else.

The CHAIRMAN. Mr. Price.

Representative PRICE. Mr. Chairman, earlier in the day during the colloquy between the Senator from Tennessee, Mr. Gore, and the Chairman of the Commission, Mr. Strauss, there may have been some inference left to the effect that perhaps Congress had delayed consideration of the indemnity legislation which is considered to be so important in the industrial participation program. I would like to insert, with unanimous consent, at this point some pertinent information, giving a chronological history of the indemnity legislation, particularly as far as this committee is concerned.

On January 26, 1956, I addressed a letter to the Commission requesting that a study be made of the feasibility of providing some sort of indemnity program for the private participants in this program. I would like for that letter to be inserted in the record.

In this letter I said that I would greatly appreciate hearing as to what the current status of the indemnity problem was, and if possible, what the Commission felt the ultimate solution might be.

I did not receive a reply to that letter for about 30 days. As a matter of fact, I received the reply on February 24, 1956.

The substance of the Commission's position at that time was that it was continuing to give careful consideration to the problem, but had not yet reached a decision whether Government insurance will be needed.

I would like for the Commission's letter to be included in the record at this point.

The CHAIRMAN. Without objection, the letters will be inserted in the record at this point.

(The information referred to follows:)

CONGRESS OF THE UNITED STATES,
JOINT COMMITTEE ON ATOMIC ENERGY,
January 26, 1956.

Mr. LEWIS L. STRAUSS,
Chairman, Atomic Energy Commission, Washington, D. C.

DEAR MR. STRAUSS: During recent months I have received expressions of concern from the management of some of the power-generating companies that the early advent of the use of nuclear energy to generate electric power on a large scale is being seriously delayed by the inability to obtain adequate and reasonably priced insurance against the industrial hazards of such a plant.

It has been noted that in recent days a group of underwriters have joined together and offered to write insurance up to a limit of $50 million. I am also aware that the Commission has an advisory group studying this very problem.

I would greatly appreciate hearing from you as to what the current status of this problem is and to the extent possible what the Commission feels the ultimate solution might be.

I recognize that this subject may be one which will be thoroughly discussed in the coming months in great detail, but for my purpose at the moment a short report would be satisfactory.

Sincerely yours,

MELVIN PRICE,
Chairman, Research and Development Subcommittee.

UNITED STATES ATOMIC ENERGY COMMISSION,
Washington, D. C., February 24, 1956.

Hon. MELVIN PRICE,
Chairman, Research and Development Subcommittee,
Joint Committee on Atomic Energy,
Congress of the United States.

DEAR MR. PRICE: This is in reply to your letter of January 26, 1956, requesting information on the current status of the problem of insuring private atomic energy facilities.

The group of insurance executives which has been studying this problem indicated in a report submitted in June, as you will recall, that most of the types of insurance required for such facilities could apparently be provided by the insurance industry. The report stated, however, that the most difficult problem was that of provision of adequate amounts of third-party liability insurance. The Commission requested comments from prospective owners and builders of reactors with respect to the group's conclusions. The general view expressed in the comments received was that while it was probable that adequate insurance would be available for other types of risks, assurance was lacking that adequate third-party liability coverage would be provided. There have been numerous other expressions of opinions by prospective builders and owners of atomic energy facilities that the private insurance industry would not be able to provide adequate amounts of this type of coverage.

The insurance industry has recently initiated organization of syndicates to underwrite insurance on atomic energy installations. They expect that $60 million will be available for public liability coverage per project and that the available coverage on the plant and equipment in atomic energy installations will be $50 million per project.

The insurance executives group has stated that it is not its function to recommend for or against Government coverage of atomic energy risks above the amounts their industry will write. This group has also indicated that the premium rates for insurance on atomic energy facilities will have to be developed on a case by case basis. They estimate that it will take several months to complete organization of the syndicates, develop forms, and be prepared to make commitments for insurance.

The estimated amounts of liability coverage to be provided are more than double those known to be heretofore available. In spite of this, there are indications that these amounts will not be deemed adequate for power reactor installations by a large proportion of the atomic energy industry. Some organizations

have stated that it will be necessary to have protection available equal to their total corporate assets.

The only experience available indicates that the probability of reactor accidents involving extensive radiation damage is extremely remote. There were no accidents in the United States involving radiation injury sufficient to cause lost time of personnel during 607,000 reactor operating hours and nearly 18 million man-hours of exposure in reactor plants from 1943 through 1954. The safety record in the United Kingdom is similarly favorable.

The Commission is continuing to give careful consideration to the problem, but has not yet reached a decision whether Government insurance will be needed.

The testimony presented by the Commission to the Joint Committee on Atomic Energy at the recent hearings on the development of the atomic energy industry covers this subject in some detail.

Sincerely,

W. F. LIBBY
(For the Chairman.)

Representative PRICE. Subsequently, on the basis of a bill I proposed in the House, H. R. 9701, on March 1, 1956, the chairman of the committee at that time, Senator Anderson, from New Mexico, decided that the Joint Committee sponsor a seminar on the indemnity subject. That was the first time anyone had moved to bring this matter of indemnity to a head. Subsequently we had further hearings on the bills that were introduced on the subject of indemnity. It is true that on February 20 the Commission gave a sort of official expression to the committee that it was favorably inclined toward an indemnity program, but it did not state any definite plan. It did state categorically at that time that it was not yet ready to submit a proposal to Congress on the subject.

It was not until the first day of the hearings on H. R. 9701, and jointly on a bill which later was submitted, I think on March 7, by the gentleman from New York, Mr. Cole—I think those hearings began on May 15, 1956, just a little over 2 months before the adjournment of the last session of the 84th Congress—that the Commission came forward with its first proposed legislative recommendation.

Subsequently, on May 16, Mr. Cole introduced the Commission bill in the House. The hearings of the congressional committee continued, and on June 29 the committee reported in the House H. R. 12050, and Senator Anderson reported a companion bill in the Senate.

I draw attention to the fact that by the time all these processes were carried out it was June 29, approximately 4 weeks before the adjournment of the last session of the 84th Congress. It would have been nothing short of a miracle if we were to be expected to have any amount of luck in securing approval before adjournment.

The CHAIRMAN. I might state to the gentleman from Illinois, and for the public and press, that it is the thinking of the chairman that soon after we complete these hearings we will take this measure up.

Are there any other questions? If not, Mr. Murray, thank you very much.

Mr. MURRAY. Thank you, Mr. Chairman.

The CHAIRMAN. Tomorrow we will hear witnesses from industry. We will meet in this same room at 10 o'clock. The Commission, under the present agreement, will appear Monday morning, February 25.

As I stated at the beginning of the hearing, we will insert the detailed statements of the Commission at this point.

The committee is adjourned until tomorrow morning at 10 o'clock.

(The detailed statements referred to on p. 5 follow:)

UNITED STATES ATOMIC ENERGY COMMISSION

FEBRUARY 1957.

Material Prepared for Hearings by the Congressional Joint Committee on Atomic Energy Held Pursuant to Section 202, Atomic Energy Act of 1954

II. ISOTOPES—FIRST PEACEFUL DIVIDEND FROM UNITED STATES ATOMIC INVESTMENT

Radioisotopes have proven to be one of the most important peaceful uses of atomic energy, other than peace itself. September of last year marked a full decade of radioisotope distribution. From the beginning, no classification restrictions have attended the use of the range of isotopes of atomic weight corresponding to lithium through bismuth. The applications of radioisotopes now have become an everyday part of America's industrial life, and there are good reasons to believe that they have attracted perhaps less attention than they really deserve.

In 1953 it was estimated that radioisotopes were saving American industry about $100 million per year. This figure, admittedly, was based on fragmentary evidence compiled by members of the Commission staff. In the hearings before your committee last year, pursuant to section 202, the basis for these savings was explained in somewhat greater detail and the prediction was made that they might reach 10 times their present value within the next decade. A more careful spotcheck this year, based on interviews with some of the many industries using radioisotopes, indicates that the savings now lie between 295 and 485 million dollars per year with a probable value of over one-third of a billion dollars per year.

There is ample reason to believe that this value of one-third of a billion dollars per year will itself continue to grow. First, the known applications of radioisotopes techniques have by no means saturated the market. It is estimated, for example, that the market for radioisotope thickness gages is less than 10 percent saturated. Such installations on the average, have been found to pay off the initial investment in less than a year—generally within a few months. Secondly, the application of low-level radioisotope tracer techniques to process control is just emerging from the experimental stage. On bulk products, such as petroleum, sorting of shale from coal, etc., a net saving of a penny or two per ton of the product could, if fully exploited, rapidly mount to several millions of dollars per year.

In arriving at these estimated cost savings, which will be discussed in more detail below, the cooperation of many American manufacturers was received. While there was an understandable reluctance to reveal company trade secrets, they were for the most part generous in furnishing specific information to the Commission regarding cost savings in certain applications. Some of the reluctance to furnish detailed information stemmed from not wishing to inform competitors of the degree of success attained in the application of radioisotopes. It is therefore possible to present data on these subjects only in the broad terms of totals or averages, with a few specific examples which can be utilized without jeopardizing the company data frequently revealed to our surveyors in confidence.

Licensed industrial users

At the end of December 1956, 3,663 United States organizations had been issued licenses to possess and use byproduct radioisotopes. Of these 1,493 were industrial organizations. The industrial users increased by 141 during the past year alone. A large number of users are not tabulated since they obtained radioisotopes under the Commission's general license for small quantities. Those holding specific licenses fall into the following categories:

Hospitals and private practicing physicians	1,533
Industrial organizations	1,493
Colleges and universities	248
Federal and State laboratories	62
Foundations and institutes	282
Other	45
Total	3,663

Survey of industrial uses and savings

In the survey of selected firms to obtain information for use in estimating the contribution of radioisotope utilization to the national economy previously mentioned, approximately 40 firms were visited, and information from more than 100 other radioisotopes users also was utilized in the study.

Probable low and probable high cost savings were estimated for a number of industrial applications of radioisotopes. Total savings to industrial firms in this country, as of December 1956, were estimated at a probable low of $295 million, and a probable high of $485 million. The average of these two figures is $390 million—more than a third of a billion dollars.

The table below gives a detailed itemization of estimated rate of savings from isotopes. It is clear that industry alone probably is saving in excess of one-third billion dollars annually.

Estimated rate of industrial savings

	Annual savings in millions of dollars, December 1956	
	Probable low	Probable high
Cigarette density gages (approximately 2,235 licensed)	35.1	58.6
Metal thickness gages (approximately 185 licensed)	18.5	27.8
Rubber and tire fabric thickness gages (approximately 120 licensed)	7.9	20.0
Plastic and adhesive thickness gages (approximately 108 licensed)	1.6	4.9
Paper and allied products thickness gages (approximately 299 licensed)	18.6	20.0
Other thickness gages (approximately 130 licensed)	2.0	5.9
Gages such as liquid level, moisture, H-C ratio, snow, etc. (approximately 3 0 licensed)	1.8	5.4
Radiographic testing (approximately 500 licensed)	26.0	58.5
Oil well logging	16.0	24.0
Oil well stimulation	120.0	180.0
Pipeline oil flow	.5	.7
Petroleum refining	5.3	10.1
Other applied industrial tracing	12.5	25.0
Tool wear studies	.8	1.2
Piston ring and similar wear studies	12.0	18.0
Corrosion studies	3.0	4.6
Other industrial research	12.0	18.0
Luminescent sources	1.7	2.7
Miscellaneous industrial applications	.5	.8
Total	295.8	486.2
Average	391.0	

In addition to the above estimates of direct savings, there is another area of cost savings to which the use of radioisotopes undoubtedly contributes although their role is more difficult to assay.

As the uses of radioisotopes increase and they become an accepted part of a new manufacturing or fabrication process, it becomes more difficult to identify savings attributable only to the use of radioisotopes. For example, in the submarine *Nautilus* many of the major welds were checked by means of cobalt 60. It is difficult to say to what extent construction of the *Nautilus* might or might not have been held up had recourse been necessary to slower and less satisfactory X-ray procedures. Further, if failure of some weld had resulted in loss or incapacitation of the submarine it is difficult to say what fraction of the total cost of the submarine might have been "saved" had a radioisotope inspection technique been used.

The field of preventive maintenance also offers many examples. Radioisotopes are widely used in reflection-type beta or gamma gages to determine the rate of internal corrosion of pressure vessels such as heat exchangers and catalytic crackers. Periodic measurements, made without interfering with the process, show when the wall of the pressure vessel has become so thin that it may not withstand the required working pressure. The vessel can then be replaced on a maintenance basis rather than as part of a rehabilitation of the whole plant following a fire or explosion.

It is difficult to set any value on such "savings," but suffice it to say that such techniques are now becoming an accepted part of industrial processes, and many manufacturers would be inconvenienced were their use suddenly taken away.

Major types of industrial uses

As the table shows, today's major industrial applications of radioisotopes include industrial research, thickness and density gaging, industrial radiography, and applied industrial tracing. These general fields include hundreds of specific applications. A few typical ones are discussed below.

Industrial research.—Radioactive tracing has been made an invaluable contribution to industrial research in many fields. Cost savings and other financial benefits from this research technique include savings in time through ability to perform research more rapidly, savings in materials—made possible by tracer research, and development of new or improved products.

One of the most common research applications of radioisotopes is in studies of wear of various materials and parts. Virtually all motor research laboratories have adopted this method for studying wear of piston rings and other moving parts. One research company official, interviewed in the Commission's survey, estimated that through radioisotope techniques piston ring wear studies could be conducted at a cost only one-fiftieth of that of previous techniques.

A variation of this technique is in the study of wear of machine tools. Not only is the radioisotopes technique more precise, but also it provides data in a few weeks which would take a year to obtain through older methods. Other important research applications include corrosion studies, tracing of chemical applications, surface chemistry, and testing efficiency of washing machines and detergents.

Gaging.—More than 3,375 gages of various types have been licensed. Thickness gages are used in the production of paper, rubber, tire fabric, plastics and other manufacturing operations where continuous, nondestructive gaging of thickness is desirable. These gages have improved the uniformity of products, have speeded plant operations, and have reduced wastage of materials. Company officials estimated that gages generally produce savings equal to their purchase price in a year or less.

Density gages have come into common use in the cigarette manufacturing industry, with more than 2,000 licensed. Through improved uniformity of the product, they have made tobacco savings possible—probably up to 3 percent as compared with former manufacturing costs for the industry as a whole. Other types of gaging include measurement of liquid levels (as in the measurement of molten steel in a furnace), moisture content, and hydrogen to carbon ratio (as in preparation of petroleum products).

Industrial radiography.—About 500 organizations are using radioisotopes for radiographic testing. Because they are considerably less bulky than X-ray equipment, radioisotope sources can be used in many places where industrial X-rays of welds and castings would be impossible. Capital investment for equipment is less, and labor savings are possible. Several firms estimated that radiosotope radiography may be accomplished for one-eighth to one-tenth the cost of X-ray radiography.

Applied industrial tracing.—The tracing technique has been applied not only to industrial research, but also to monitoring a variety of industrial processes. Probably the most important applications of tracing techniques have been in the petroleum industry.

Radioisotopes have proved to be an important aid in oil well stimulation. One such application involves the use of acid in bore holes to dissolve sandstone blocking the flow of oil into the hole. Before radioisotopes came into use, it was difficult to determine whether the acid was being placed at the desired depth. Labeling the acid with a radioisotope makes it relatively easy to determine where it is being placed. This and a dozen other techniques are saving oil companies from $120 to $180 million a year, according to the survey.

Radioisotopes are also being used to monitor the flow of oil through pipelines, and to trace the circulation of catalyst in catalytic cracking plants. Radiation sources also have proved to be a valuable aid in locating oil-bearing strata. Altogether, it is estimated that the petroleum industry is saving from $140 to $215 million annually through the use of radioisotopes.

As the above discussion indicates, radioisotopes already are being used routinely in some segments of industry, with material benefits in cost savings and improved products. There is no question that industrial applications will continue to increase, particularly in process control.

Outstanding new uses developed by or for industry

Besides industrial uses already developed and applied, as described above, new applications are emerging. Activities of private industry during the past

10 years in the use of radioisotopes in research, development, and process control have provided the foundation for their further utilization as commercial scale sources of radiation in the food, drug, chemical and other industries. Practical application of million-curie radiation sources in these industries is about to be realized. Several firms already have expressed research interest in utilizing such radiation sources for food preservation, sterilization of drugs and medical supplies, and initiation of chemical reactions.

Direct benefits to the public in terms of the availability of consumer products which employ small quantities of radioisotopes can now be envisaged. Several such products already have been marketed by private industry. These include a photographic light meter and an air ionization device. Private firms currently are considering other household items in which radioisotopes might advantageously be employed, such as luminous light switches and luminous markers for automobiles. Safeguards to public health and safety present unique problems requiring particularly critical evaluation to assure that their use is not harmful.

Other novel industrial uses of radioisotopes currently under study, while not having such widespread implications, nevertheless are of significance. Such uses include studies of the mechanism of penetration of detergents through skin, factors affecting the depletion of additives in diesel engine operation, radiation effects on the process of combustion, and on fat absorption during the deep frying of bakery products.

Radioisotopes in medical research and therapy

The American people, the medical profession, and the Commission will not try to place a dollar value on extension of the life span or surcease from suffering. Accomplishments such as these are valued in the coin of human dignity and happiness. However, there is an economic gain from the healing power of the isotopes, as from that of all the substances and skills applied in medicine.

It is estimated by one reputable medical authority that approximately 800,000 persons per year are now being diagnosed and/or treated with radioisotopes. Another authority places this figure somewhat higher—between 900,000 and 1 million patients per year. As remarked above, it is more difficult to point to a medical patient and to associate with him a "dollar saving" than it is to obtain comparable figures for industry by looking at cost and production charts. Nevertheless, if, for example, a leukemia patient can be given another 3 years of life expectancy through the use of radioisotopes and continues to remain a productive, though not fully active member of our society, some fraction of his added productivity, from the point of view of an economist, might be credited to the national well-being.

The cost of removal of the thyroid gland by surgical means varies widely, of course, but a rough estimate by one of the leading hospitals in the United States indicates the use of radioiodine appears to lower the cost of treatment for average cases by about $100, representing for the most part a net savings in out-of-pocket expenses because of a shorter stay in the hospital. In severe cases the reverse may be true. Radioiodine, however, is not necessarily the treatment of choice, the decision of radiotherapy versus surgery being that of the physician. However, with many thousands of thyroidectomies being performed in the United States annually, there appear to be possibilities for significant savings to the persons affected.

There is in some places a trend toward using cobalt 60 in preference to X-rays. We have recently learned of one large university medical center which is currently giving 900 to 1,000 treatments a month with its cobalt 60 unit, as compared with some 300 treatments a month with conventional high-voltage X-rays.

There are many other applications of radioisotopes including neutron-beam therapy which is still in its experimental infancy and which appears to show considerable promise. No estimate of therapeutic or financial benefits could be made at this time.

If radioisotopes can successfully be used in the field of geriatrics, the studying of the aging process in humans, one can foresee almost incalculable savings to our national economy.

The results of such calculations lead to the conclusion that the patients themselves generally have but little direct cash benefits from the applications of radioisotopes to medicine. There are, however, many persons who would not be alive today and making a productive contribution to the Nation's economy, and society and their families were it not for the magic of radioisotopes.

Radioisotopes in agriculture

Last year an estimate was made that the potential savings of radioisotopes in the field of agriculture might reach some $210 million per year. There is no reason to doubt the order of magnitude of these figures. The eradication of the screwworm fly from one of the small Caribbean islands through the use of cobalt 60 and at a cost of about $100,000 has shown it is possible to eliminate this pest almost completely. To perform the same task in the Southeastern United States would require an estimated expenditure of approximately $3 million to $8 million with an estimated potential saving of $15 million to $20 million per year. Similarly, fertilization experiments using tobacco and corn appear to indicate present savings of $100,000 to the State of North Carolina alone. One estimate shows a present total national savings from using radioisotopes in fertilizer studies of around $0.5 to $1 million per year, based on spot checks.

While these figures appear small as compared to the earlier data on industrial usage, what is needed now to translate potential into probable savings appears to be the enormous task of training, education, and demonstration by the farm organizations, and State, Federal, and county agricultural experiment stations and extension systems. It is not the uses of radioisotopes themselves which need be passed on to the farmer—only knowledge as to improvements in farm crops and practices translated from the research which utilized isotopes. There is every reason to anticipate that when this translation can be accomplished and made available to the Nation's farmers, the estimated potential savings of $210 million per year can, in a large measure, be realized within the foreseeable future. Such savings could be reflected in an improved farm productivity at lower unit costs not only in this country but also in other nations.

Private enterprise in production, processing, and redistribution

Currently, nearly 100 private firms are engaged in radioisotope processing and redistribution as contrasted with 17 in 1951. Several times this number provide accessory equipment and services. Participation of private enterprise in these activities has characterized the radioisotope program since its beginning. In response to the rapidly growing industrial demand for radiation sources, several firms presently are expanding their radioisotope processing facilities very significantly.

Tracerlab, Inc., for example, shortly will occupy new expanded facilities in Waltham, Mass. Abbott Laboratories, in Oak Ridge, Tenn., doubled its plant facilities for radioisotope processing. The nuclear systems division of the Budd Co. in Philadelphia, Pa., recently completed a hot cell capable of handling 10,000 curies of cobalt 60.

For the first time since initiation of the radioisotope distribution program in 1946, the economic feasibility of private enterprise participation in radioisotope production appears imminent. Actual undertakings by private industry in this area primarily are dependent upon sufficient further development of the radioisotope market to support private radioisotope production reactors.

Actions taken by Commission to encourage industrial uses of isotopes

To the extent consistent with the public health and safety, Commission regulations pertaining to the possession and use of radio isotopes have been revised and simplified to facilitate the use of radioisotopes for industrial and other purposes. Quantities of radioisotopes which may be possessed under general authorization or license have been increased. Provision also has been made for distribution by manufacturers of several devices employing radioisotopes without specific licensing of their customers. In the case of export of radioisotopes with atomic numbers 3 to 83, inclusive, to friendly countries, the previous requirement for prior Commission approval has been removed.

To facilitate the licensing procedure for applicants, the application form for byproduct material licenses has been extensively revised to reflect more fully the information required in current licensing practice. Supplementing this, the Commission has expanded its program of prelicensing visits to applicants' facilities. This not only expedites the licensing process, but also provides the applicant an opportunity to obtain on-the-spot advice concerning radiation protection matters. To provide for the rapidly growing industrial demand for radioisotopes, particular attention is being given to probable future requirements and means of meeting them. For example, the Commission has made available spent fuel elements from the material testing reactor at Idaho Falls, Idaho, for use as sources of gama radiation. Similarly, provision has been made for production of cobalt 60 at Savannah River at the rate of 200,000 curies per

year through December 31, 1957. This material, together with that produced in other Commission reactors, will increase the availability of cobalt 60 for civilian use in 1957 to a minimum of 300,000 curies.

The Commission is presently constructing a multicurie fission products pilot plant at the Oak Ridge National Laboratory. This facility will help to meet the demands during the initial stages of industrial development of the utilization of the long-lived radioactive fission products. It also will serve as a pilot plant for future industrial fission product separation plants. Construction should be completed in April 1957 and the plant should be ready for full-scale production by July 1957. This facility will have a capacity for the separation of 200,000 curies per year of cesium 137 (30-year half life). In addition, substantial quantities of strontium 90 (28-year half life), cerium 144 (275-day half life), and technetium 99 (2 million year half life) also will be recovered from the same radioactive wastes. Those radioisotopes will be used widely in medical research and therapy, physical research, and industry.

To further aid the growth of industrial radioisotope applications, the Commission has increased the audio visual aids available to industry on radioisotope technology and uses. Commission personnel also continue to participate in meetings of national professional and business organizations to disseminate information on these subjects.

Markets for industrial products developed through biological and medical atomic research

New products of agriculture are being developed through the effects of atomic radiation on plant varieties. New methods of fertilization of crops and orchards are resulting from isotopic tracer research. New types of insecticides and fungicides and methods of application are following upon new knowledge of the life cycles of crops and livestock pests developed by tracer research. These new atomic developments eventually will result in demand for new types of equipment and materials to be used on the Nation's 5 million farms or in the hundreds of thousands of processing plants handling agricultural products on their way to consumers here and abroad.

Similarly, the new techniques in medical diagnosis and therapy, rapidly developing as a result of the use of atomic materials in medical research and practice, are creating demands for new types of medical equipment and materials.

The largest industrial opportunity opened up in the fields of agriculture, biology, and medicine, including radiation safety, is of course in the design, manufacture, and distribution or radiation-detection instruments.

To round out the picture of the developments in this aspect of the atomic energy industry since we last entered testimony under section 202 of the Atomic Energy Act, the Commission has compiled a brief résumé of the new-equipment requirement in the medical-therapy field and in the general field of radiation-detection instruments. The results for the teletherapy and brachytherapy applications are discussed below.

Medical teletherapy.—Cobalt 60 for use in treatment of cancer is produced in the United States in the reactors at the Commission's Savannah River plant and in the materials testing reactor in Idaho. The production of cobalt sources for teletherapy in North America has increased from 1, at the initiation of production in 1950, to 123 in 1956. Of these 123 sources, 63 were produced in the United States, and the remainder in Canada.

The cost of these sources ranges from $2,000 to $20,000. The cost of the machines in which they must be installed for utilization ranges from $20,000 to $70,000.

Although it is extremely difficult to estimate world requirements for cobalt 60 sources, some estimates place them by 1966 in teletherapy alone at 4 million curies of 4,000 sources at an average of 1,000 curies per source. One and one-half to 2 million curies, or 1,500 to 2,000 average sources, is the prediction for the United States. The production of machines to accommodate these sources must keep pace with the production of sources. Eventual conversion of all conventional medical X-ray machines in the United States to cobalt 60 teletherapy units would require the production of roughly 2 million curies or 2,000 average sources in the next 5 years. Among the advantages of cobalt 60 teletherapy over X-rays are less reaction of the skin, less discomfort to the patient when deep therapy is indicated, the deeper penetration into the body for treatment of deep-seated lesions.

Recent developments indicate that cesium 137 may provide almost as good therapeutic possibilities as cobalt 60 while at the same time offering real advantages in its longer source life and ready availability as a byproduct from

fission products of reactors. A high activity cesium 137 source (2,045 curies) was made available to the University of Michigan recently to be used in a clinical study of the comparative effectiveness of cobalt 60, cesium 137, and conventional X-rays in therapy.

Brachytherapy devices.—Brachytherapy devices employ sources of radiation measured in thousandths of a curie instead of thousands of curies. Among the devices now in use are guns to inject small "seeds" of radio-elements into a tumor; cobalt seeds on nylon thread that can be sewn into breast tumors; cobalt 60 in combination with corrosion resistant alloys that can be machined into any desired shape; needles; seeds; beads; or small cups to be placed behind the eyeball surgically. Europium 152 with a longer half life than cobalt 60 is used in these devices also. All of these devices are placed in the patients' body for only a temporary period of time, ranging from a few hours up to several weeks. Other devices are used which become permanent fixtures in the patient's body. Among the isotopes used for this latter type of treatment are cesium 137, yttrium 90, and gold 198. These materials are placed in the body of the patient by implant or by flowing through tubing.

Instrumentation

The utilization of radioisotopes requires radiation-measurement instruments as does the operation of atomic plants where radiation is present. During the early years of the atomic energy project, essentially all instruments were manufactured by project laboratories. With Commission stimulus and assistance, a nuclear-instruments industry was encouraged to develop. Relatively little manufacturing activity of this sort is now carried out at Commission installations. The following examples are illustrative of the ways in which private industry has been assisted and encouraged to participate in the development and growth of instrumentation required for Government and private atomic energy operations.

1. Industrial organizations are given information on requirements for instrumentation and electronic components within Commission installations and for users of radioisotopes. Information on the general market potentialities for certain types and classes of instruments, equipment, and electrical components is made available.

2. The Commission reviews new products proposed by industrial concerns and may test and evaluate them from the standpoint of AEC use. The results of such tests are made available to the company for guidance in further development work.

3. Instruments and equipment which are developed on a preliminary basis at various Commission installations and which have application to Commission programs are referred to manufacturers for further production engineering and development. If the instrument is sufficiently developed to make possible the preparation of specifications, bids are invited and contracts are let in which the requirements of various Commission installations are consolidated.

4. Detector and electrical components required for various nuclear instruments are usually developed through industrial research and development facilities. For example, the Allen B. Dumont Laboratories and Radio Corporation of America are two of the Commission's contractors in the development of new and improved types of photomultiplier tubes for use in scintillation counting, a technique that has expanded rapidly in the past few years. Based on a 1953 survey it has been estimated that of the 9 to 10 million dollars devoted by the Commission to instrument development associated with major programs, one-fourth is used for the procurement of commercial instruments developed to meet specific needs.

Future needs for new types of instruments

As in other fields, the demand for instruments expands as uses of radiation develop. Some future requirements already are discernible. For example, a need is developing for thin-walled, low-cost counters that could be mass-produced for use in high school and college teaching. Such counters need not be precision instruments but should be made available in large numbers to trained scientific personnel needed for an expanded atomic-energy program in both science and industry. The requirement of thin wall is due to the softness of the radiations from many important isotopyes. Counters could be produced, perhaps, in kit form for assembly by students.

A need is developing for inexpensive counters, some of thin walled, for medical diagnosis and therapy. A typical geiger or scintillation counter costs half as much as a television set. Internally they are far less complicated than a table radio and should be mass producible at well below their present cost. Volume

production is the answer to lower costs; coordination of potential purchase requirements among the tens of thousands of high schools and colleges might make this possible.

Sensitive elements no larger than an eraser are needed for the construction of probes to be inserted inside the brain during brain-tumor surgery in which the location and extent of the tumor is delineated by previous injection of radioisotopes into the blood stream of the patient.

Perhaps the largest potential new future market is for low-level industrial counting apparatus in which the activity to be measured is equal to or perhaps even less than normal background. Such counters will be needed in the application of low-level tracer techniques to industrial processes, such as the production and refining of petroleum, etc., in which a radioisotope is added to the product so that its movements during the manufacturing process can be traced and perhaps automatically controlled. It is to be emphasized that the radioisitopes added must be such that they decay to an insignificant activity before the products are offered to the public. Such industrial users are entirely feasible and await development of low-level counters at reasonable cost.

In summary, the application of radioisotopes to industry, medicine, and agriculture continues to be one of the bright spots in the atomic-energy program. Justification has been presented for the reasoning which leads to an estimated savings of nearly one-third of a billion dollars in industry and potentially an almost equal amount in agriculture. There are incalculable but sizable potential savings to our national economy in medicine. Each one of these uses taken individually would represent a fair net return on the capital investment of our entire atomic-energy program. Best of all, the benefits of radioisotopes are immeditaely applicable.

III. Raw Materials Base for the Atomic Energy Industry

General statement[1]

For the United States, 1956 was a year of rapid progress in the development of its uranium industry. This country is now the leading uranium producer of the free world and is currently furnishing approximately one-half of the supply employed in our atomic-energy program. Increases in deliveries from foreign sources last year were exceeded by gains in domestic production.

Mining and milling operations in the United States have greatly expanded. Ore production now is about 3,500,000 tons a year and is expected to be in excess of 5 million tons annually within the next 3 years. In the past 12 months mill-conocentrate production increased from an annual rate of about 4,000 tons of U_3O_8 to a rate of 8,000 tons. Production for the year was approximately 6,000 tons of U_3O_8. By the end of 1958, the rate is scheduled to be in excess of 15,000 tons a year.

Probably the most important development has been the large addition to our known ore reserves. This was due to the intensive development of uranium deposits and uranium-bearing areas previously found rather than to new discoveries. Most important was the development of the Ambrosia Lake field, near Grants, N. Mex. This field was discovered only in April 1955. Ore reserves are now estimated at 25 million tons averaging 0.3 percent U_3O_8. This represents approximately 40 percent of known domestic reserves, which currently are estimated at about 60 million tons. Nearly 70 percent of these reserves lie within 30 miles of Grants.

The Canadian uranium program also progressed rapidly during 1956. Although production in Canada has not increased as rapidly as in the United States, mine development and mill construction are proceeding rapidly. By 1958 the production rates of the two countries may be about equal. The greatest development is taking place in the Blind River field, Ontario, about 100 miles north of the Canadian-United States border. Since the discovery of commercial deposits in this area in 1953, approximately $175 million of private capital has been spent or committed for opening uranium mines and constructing mills. By 1958 the total may reach $250 million. Mining and milling, which was at a rate of 7,000 tons of ore per day at the end of 1956, will progressively increase as new mills are completed until 1958 when the scheduled rate of about 35,000 tons a day should be reached.

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[1] Some of the production figures appearing in this testimony may be found in the 21st semiannual report to the Congress at pp. 3–8. The figures repeated here are given as necessary underlying data for the discussion of the development of the raw-materials phase of atomic-energy industry here and abroad.

An official Canadian estimate of reserves in the Dominion as a whole, issued in mid-December, placed them at 225 million tons. The major part of these are in Blind River district, where the grade averages approximately 0.1 percent U_3O_8, or about 2 pounds per ton.

In the Beaverlodge area of northern Saskatchewan, mining and milling operations at the end of 1956 were at the rate of 2,000 tons of ore daily. Expansions and new construction now underway should double this rate by the end of 1957. The Bancroft area, 150 miles north of Toronto, has 1 mill in operation and 2 under construction. Total milling capacity should reach 3,000 tons of ore per day. Uranium prospecting in Canada has almost ceased as a result of the Canadian Government's announcement in July 1955 that no proposals for milling contracts would be accepted after March 31, 1956.

The South African program reached approximately 80 percent of full production with the completion of 16 mills of a total of 17 approved for the program. In 1957, production should approach maximum with 17 mills drawing tailings from 27 gold mines. When all plants are in full operation more than 20 million tons of tailings containing approximately one-half pound of U_3O_8 per ton will processed annually.

The Belgian Congo continues to be an important producer, but its relative importance has declined because of the large new production now coming from the United States, Canada, and South Africa. Portugal continues to be a small but steady supplier of uranium.

In Australia, production is being maintained from the two Government-owned properties previously brought into operation. Australia is considered a favorable continent for exploration with a large undeveloped potential.

The great change in uranium production over the past 9 years was emphasized by an action taken last December—the declassification of information on current and future uranium production and ore reserves. During the earlier period of the Commission's operations a supply of uranium sufficient for the expanding defense program posed serious problems and information concerning availability of uranium had important security value. In 1948, more than 90 percent of our uranium came from overseas. Since then overseas production has increased severalfold, but the largest new sources of production which have been developed are on the North American Continent. Today North America is furnishing more than 60 percent of the United States uranium supply, and by 1958 it will be providing about 80 percent of a much greater total supply.

A production rate is now assured which will be sufficient not only to meet defense requirements but also to provide for industrial power development. The uranium supply no longer is a limiting factor in either the civilian or the military program. The world is on the threshold of a great atomic-power development.

Henceforth, the uranium industry should be able to plan ahead in the light of full information on current and potential supplies of ore. Such information no longer needs to be classified for military reasons. On December 13, 1956, the United States and Canada made public current and future data on production and reserves. South Africa has taken similar action. Another important step taken during the past year was the establishment by the Commission of a new procurement program which provides a domestic uranium market through 1966. This program was designed to support continuing domestic exploration and development so that domestic production can continue to supply a substantial part of our military and power requirements. The new program, by converting to a concentrate rather than an ore price, establishes a uniform base for market quotations on the primary product desired by industry and thus anticipates transition from a Government-controlled market to a commercial market.

The present status of domestic uranium operations

Mining operations.—Uranium ore production in the United States was at an annual rate of approximately 3,500,000 tons in December 1956. This compares with an annual rate of 1,800,000 tons in December 1955. Production is expected to increase rapidly toward the end of 1957 and in early 1958 as new mills now planned for New Mexico, Wyoming, and Washington go into operation. By the end of 1958, ore production may reach an annual rate of 5 million tons or more.

The trend today is toward larger mining as well as milling operations. Our greatly increased domestic-production capability is the direct result of the discovery of large ore deposits. Many of these large deposits can be mined economically only by large-scale operations requiring large capital investment prior to production for development, equipment, and facilities.

It is interesting to note, however, that there has been a continued increase in the number of producing mines, in the number of small shippers, and in total

production of the small shippers. We have arbitrarily defined a small shipper as one producing not to exceed 10,000 tons of ore in a 6-month period, which would be an everage of about 65 tons of ore per day. Comparing the first 6 months of each of the past 3 calendar years 1954, 1955, and 1956, the number of individual mining operations was 795, 809, and 1,005; the number of small shippers was 443, 459, and 511; and the number of large shippers was 11, 14, and 19. A number of the mining operators, both small and large, have more than one mining operation.

For the same period the aggregate production of the small shippers increased 80 percent and the aggregate production of the large shippers increased more than 300 percent. Although the production of the small operations increased substantially, the larger operations are now accounting for a major part of our production. In the first half of 1954, small shippers accounted for 37 percent of our total ore production but only 25 percent in the first half of 1956, notwithstanding an 80 percent increase in their total shipments. This trend will continue with opening of large mines in the Ambrosia Lake field.

The 19 largest shippers, those which produced in excess of 10,000 tons each, delivered 75 percent of the ore received at domestic mills and buying stations during the first half of 1956; 10 of these large shippers were relatively small companies. The 9 largest companies produced about 53 percent of the total tonnage delivered in the 6-month period.

Milling operations.—On December 31, 1956, there were 12 mills in operation including the AEC-owned plant at Monticello, Utah. A list of the operating mills and their capacities follows:

Name	Location	Capacity, tons ore per day
The Anaconda Co	Bluewater, N. Mex	3,000
Atomic Energy Commission	Monticello, Utah	600
Climax Uranium Co	Grand Junction, Colo	350
Kerr-McGee Oil Industries, Inc	Shiprock, N. Mex	500
Mines Development, Inc	Edgemont, S. Dak	300
Rare Metals Corp	Tuba City, Ariz	250
Union Carbide Nuclear Co	Rifle, Colo	280
Union Carbide Nuclear Co	Uravan, Colo	850
Uranium Reduction Co	Moab, Utah	1,500
Vanadium Corporation of America	Durango, Colo	430
Vanadium Corporation of America	Naturita, Colo	350
Vitro Uranium Co	Salt Lake City, Utah	550
Total		8,960

Total milling capacity, which at the end of 1955 was 5,500 tons of ore per day, was increased materially by the completion of 3 new mills and expansions at several exisiting plants. The estimated investment in the privately owned mills now in operation aggregates $50 million.

During 1956, contracts involving the construction of nine new mills were negotiated. A list of those mills, which should be completed in 1957 or early 1958, follows:

Name	Location	Rated capacity, tons ore per day
Atomic Fuels Extraction Co	Bedrock, Colo	200
Dawn Mining Co	Ford, Wash	400
Gunnison Mining Co	Gunnison, Colo	200
Homestead-New Mexico Partners	Ambrosia Lake area, New Mexico	750
Lost Creek Oil & Uranium Co	Split Rock, Wyo	400
Lucky Mc Uranium Corp	Freemont County, Wyo	750
Texas-Zinc Minerals Corp	Mexican Hat, Utah	775
Trace Elements Corp	Maybell, Colo	300
Union Carbide Nuclear Co	Rifle, Colo	1,000
Total		4,775

The estimated private investment in the mills listed above is on the order of $40 million. In addition to the mills now operating and those under contract

and construction, others are being planned by industry, including some with capacities in excess of 1,000 tons per day. The Commission has before it for consideration proposals involving the construction of 6 additional plants.

The Commission's process development program has been an important factor in speeding mill construction and expanding uranium concentrate production. New processes developed under this program have reduced production costs, increased recovery and simplified mill design and operations. This in turn has resulted in lower concentrate prices to the Commission. The Commission now has accumulated extensive operating data and also has a modern pilot plant for testing various types of ores. The availability of this plant and the operating data, together with the declassification of ore processing information, make it possible for organizations without previous uranium experience to undertake the milling projects with a minimum of preliminary work.

Ore reserves.—As of November 1, 1956, domestic ore reserves, by States, were estimated as follows:

State	Tons	Measured, indicated, and inferred ore		State	Tons	Measured, indicated, and inferred ore	
		Percent U_3O_8	Percent of total ore			Percent U_3O_8	Percent of total ore
New Mexico	41,000,000	0.24	68.4	Washington	1,500,000	0.18	2.5
Utah	7,500,000	.34	12.5	Others	1,000,000	.24	1.7
Colorado	4,100,000	.33	6.8				
Arizona	2,600,000	.30	4.3	Total	60,000,000	.25	100.0
Wyoming	2,300,000	.22	3.8				

Extensive private drilling during 1956, almost twice that of any previous year, greatly increased ore reserves. This was particulary true in the Ambrosia Lake area of New Mexico where large reserves were proved on lands previously classed as potentially ore-bearing.

It should be pointed out that AEC's ore reserve estimates are based upon the results of private development and time is required to compile the data. As a result the estimates are not always completely up to date.

Development and exploration.—During the past year, uranium development in the United States passed the pioneering boom stage and the industry now is established on a sound basis. Probably more private capital was spent on uranium development in 1956 than in any previous year. In exploration, private industry drilled approximately 4,200,000 feet in the first half of 1956 as compared with 2,900,000 feet and 2 million feet for the corresponding periods of 1955 and 1954.

Most of the 1956 drilling was done in areas where uranium deposits had previously been discovered. Many of the development programs undertaken by private companies in 1955 and 1956 were for the purpose of quickly outlining their ore reserves in order to plan mining and milling operations that would result in maximum recovery of production from these reserves by March 31, 1962, which then was the end date of the Government market. Following the Commission's announcement on May 24, 1956, of a uranium procurement program which extended the Government market to the end of 1966, plans were revised to a longer range basis. Many of the larger operators are now looking beyond 1966 to a commercial uranium market. This should result in better utilization of our valuable uranium resources and in the elimination of "crash" programs which might leave in their wake ghost camps and ghost towns.

As noted in the opening general statement, the greatest addition to our ore reserves was in the Ambrosia Lake district, near Grants, N. Mex. The large extent and substantial thickness of the ore deposits justified extensive drilling programs to depths of 400 to 1,000 feet. There are possibilities of discovering still more uranium-bearing structures in the Grants area.

The ore reserves of Wyoming and Washington were also increased as a result of 1956 development and important additions were made to the reserves of the older Uravan Mineral Belt in Colorado. The Cameron and Monument Valley districts of Arizona also developed favorably. Drilling in the Big Indian district near Moab, Utah, largely confirmed earlier estimates with no important tonnage being added.

Although the major effort was directed toward developing ore reserves, private prospecting and exploration continued active throughout the United States. However, on the basis of present information, none of the 1956 discoveries in new areas appears likely to have an important effect on our overall production and ore-reserve picture.

There has been a decline in the feverish claim-staking activity which was stimulated by the speculative market for almost any mining claim situated near a well-publicized discovery. Much of this activity contributed little, if anything, to our uranium program. It appears that the increasing difficulty and cost of finding uranium deposits is tending to reduce the amount of individual prospecting. At the beginning of the program a Geiger counter was all that was considered necessary to undertake a prospecting expedition and a number of amateur prospectors achieved success. However, as the country becomes prospected by surface and airborne methods, the search must be more and more directed toward finding concealed deposits.

Many of the important discoveries of the last 3 years have been the result of drilling on geological evidence. This type of exploration, geological investigation followed by deep drilling, requires substantial risk capital. Many mining and oil companies are now doing uranium exploration of this kind.

Government exploration drilling, which played such an important role in the early search for uranium deposits, was discontinued in April 1956, with the completion of projects initiated earlier. In 1948, when the program to develop domestic uranium production was established, there was practically no private exploration. The Commission pioneered drilling on the basis of geologic evidence in areas considerably distant from outcrops or known uranium deposits. Most of this drilling was on public domain in which private industry had not been sufficiently interested to stake claims. Prior to drilling by Commission, the unappropriated lands were withdrawn from mineral entry.

Since 1952, private exploration of all types, from the efforts of the individual prospector to extensive geological and drilling programs, has rapidly expanded. Private uranium exploration in 1956 was far greater than the combined Government and private effort of 1953 when the Commission drilling program reached its peak. There no longer is a need for the Government to do physical exploration.

We have requested restoration to public domain of all the public lands withdrawn for Commission exploration except for 50 square miles on which commercial uranium deposits were discovered at Government expense. These deposits will be available for lease when the ore is needed.

The Commission's exploration program is now directed toward the evaluation of the results of private exploration, the appraisal of our potential resources of nuclear fuels for the long-range atomic power development, and the development of geological information relating to uranium ore deposits.

IV. Information Base for the Atomic Energy Industry

During 1956 there was continued growth of activities designed to conevy technical information to the atomic energy industry on the part of Government and of industrial groups, scientific and professional journals, the business press, commercial book publishers, and other private media. More than 5,000 articles and papers (listed in the AEC's Nuclear Science Abstracts) dealing with peaceful aspects of atomic energy were published by non-Government organizations during the year. The Commission increased the accumulation of unclassified data available for general use by declassifying and issuing 10,700 existing technological and basic science reports; by issuing in unclassified form approximately 2,300 new reports; and by starting a program of summarizing and organizing technical knowledge in books and current technical reviews.

BUSINESS AND TECHNICAL PRESS

During the year almost all scientific, technological, labor, and business journals published articles or in some cases entire special issues and supplements on various practical applications of atomic energy. The number of such articles has reached large proportions. For 1 month alone (August 1956), a sampling of 12 journals showed 40 special atomic industrial articles, which ranged from engineering designs to insurance problems; from special materials to economics. In addition, the news and announcement sections of most of these journals

increased their regular coverage of atomic energy subjects during the year and their book review sections now regularly include the more important Commission reports and other technical publications of use to industry and science.

Also serving the business community has been a rapid development of atomic-energy business newsletters. Some 13 are currently in existence. Other business, financial, and industry newsletters have added supplement and regular sections on atomic energy.

COMMERCIAL BOOK PUBLISHERS

The number of privately published books on the technology of atomic energy showed an increase over 1955. New texts on shielding, control of reactors, power production from reactors, thermonuclear theory, and specialized metallurgy appeared during the year and filled specific needs, but many more texts are needed. A cooperative publishers' display of books on atomic energy and related topics at the 1956 Trade Fair of the Atomic Industry held in Chicago September 25–27, 1956, included some 200 current volumes. For the first time there were many books on commercial and business aspects of atomic energy, including contracting, insurance, legal, and legislative problems, etc., as well as on the science and technology of industrial applications of atomic energy.

COMPANY AND LOCAL PUBLICATIONS

House organs of firms in the atomic-energy industry more frequently devoted space to special articles on nucleonics during 1956. A typical example was the August–September publication of an engineering firm, which carried two articles on reactors, illustrated with engineering drawings. Other firms published pamphlets and booklets on atomic energy generally and on specific phases of the companies' programs for informing and orienting their employees and their communities. The atomic divisions of still other companies published studies resulting from their own research.

Through 1956, 38 State and municipal governments, many of whom are interested in possibilities for local atomic industries, applied to the Commission for access permits. This interest, in turn, was reflected in special editions and feature series in local newspapers and magazines. For example, Greater Boston Business, official organ of the Greater Boston Chamber of Commerce, used more than half of its November 1956 issue for articles on the implications for the Boston area of atomic industry. Four of six articles were condensed versions of Commission publications for industry, thus giving the information far wider distribution in the area than would have been possible in the original booklet form.

SEMINARS, MEETINGS, EXHIBITIONS

Many other privately initiated programs resulted in the distribution of nuclear data during 1956. Early in the year, one access-permit holder, a large utility company, instituted an informal industrial nucleonics information seminar to familiarize prospective manufacturers of components for atomic powerplants with the new technology. In addition, company officers briefed the component-supplying firms on the access-permit system.

Another example of private participation in broad dissemination of information helpful to business was offered by the National Industrial Conference Board, which conducted a series of lecture, demonstration, and discussion courses on atomic energy in 1956. Prominent businessmen, engineers, and nuclear scientists served as instructors for this atomic-energy course for management. Each course, lasting 1 week, was limited to about 75 business executives who received nontechnical grounding in atomic science and in the economics of nuclear energy. Given 6 times, the courses were attended by 431 executives from the United States and from 9 other countries. The National Industrial Conference Board plans to continue and expand the series in 1957.

The year marked an increase in the number and scope of privately sponsored conferences, symposiums, and exhibitions dealing wholly or in part with atomic energy. One of the largest of the all-nuclear meetings was the Atomic Industrial Forum's Annual Conference of Management, Economics, and Technology for the Atomic Industry, Chicago, Ill., September 25–27. More than 400 firms and organizations participated. In connection with the conference, approximately 100 companies presented exhibits in an atomic trade fair, a 50-percent increase of exhibitors over the 1955 fair, according to forum officials. The 22d Biennial National Power Show, New York, November 26–30, 1956, which ran simultane-

ously with the annual meeting of the American Society of Mechanical Engineers, offered for the first time a special section on industrial atomics. Twelve major firms in nuclear industry exhibited. Attendance was open to the professional and trade group only. Show officials estimated that 30,000 visited the atomic-exhibits section.

At the December meeting of the American Society of Mechanical Engineers in New York City an all-day technical session was sponsored by the society's nuclear engineering and power divisions. The papers presented detailed design progress in six major powerplants. An indication of the intense interest in this field was shown by the attendance at this session. Nearly 1,000 engineers crowded the meeting, which had been planned for about 350.

The December meeting in Washington of the American Nuclear Society, which had been expected to draw an attendance of some 500, actually attracted more than twice as many—more than 1,100—and exceeded that of the annual meeting in June.

PRIVATE ATOMIC-ENERGY FILMS

Twelve Commission libraries in the United States have bought and stocked 42 atomic-energy films produced by private industry and technical groups. The libraries also stock 17 Government-made atomic-energy films. The films are loaned to schools, universities, technological meetings, and others, as are Commission-produced films. Librarians report that, during 1956, demand for all atomic films increased at least 50 percent over 1955. Apparently private industrial film libraries experienced the same accelerated demand. Among privately produced films in especially heavy demand were: Nuclear Reactors in Research, The Atom in Industry, A is for Atom, The Atom Goes to Sea, Dawn's Early Light, and Giant of the Earth. The complete list of 59 available private and Government atomic films, giving producers and descriptive data, was supplied to the committee in October 1956.

COMMISSION INFORMATION POLICIES AND OPERATIONS SERVING INDUSTRY

While the technical societies, business organizations, business press, and other private mediums expanded their industrial atomic information service rapidly, drawing heavily on the Commission's resources, the Commission itself took major steps to widen the range and improve the quality of information services available through documents, reference tools, and meetings, visits, and consultations for holders of access permits and others in industry.

Declassification and downgrading of industrial information

The classification policy of the Commission is a determining influence on availability of technical information to industry at large. Through the access-permit program, industry and other groups needing restricted data on peacetime applications have been afforded an opportunity to obtain it. However, the most rapid increase in the spread of knowledge and consequently in the development of private enterprise in atomic industrial lines would obviously take place if the necessary technology and economic information could be entirely free of classification. The past year saw additional new moves by the Commission to declassify data useful to the atomic-energy industry.

The policy guide in section 141 of the Atomic Energy Act of 1954 states that "the dissemination of scientific and technical information relating to atomic energy should be permitted and encouraged so as to provide the free interchange of ideas and criticisms which is essential to scientific and industrial progress and public understanding and to enlarge the fund of technical information." With this criterion in mind the Commission, in December 1956, adopted a revised policy of classification. Revisions to the declassification guide were made jointly with the classification authorities of the United Kingdom and Canada. The declassification guide states, for the three nations, general descriptions of data which may be made public without adversely affecting the common defense and security.

This new policy goes far toward enabling industry at home and abroad to design, construct, and operate civilian power reactors entirely on an unclassified basis. However, the ramifications of the policy extend into many other fields. An enlarged flow of technical and economic knowledge will benefit the atomic-energy industry generally—from uranium mining to chemical processing of spent reactor fuels—and other industries which can make use of techniques, materials, and components developed specifically for the atomic-energy industry.

The committee is familiar with the details of the new policy which were forwarded by letter prior to the public announcement on December 12.

As pointed out in the Chairman's statement making the announcement some 6 months will be required for review of the thousands of documents now classified *as restricted data, to declassify or downgrade them, and make them available in* printed or photocopy form. The first step is to review again some 20,000 documents which remained classified after the review in January 1956 which declassified 11,000 documents. Also to be reviewed are some 2,000 classified documents added during the past year. A team of 35 scientists and engineers from the major Commission installations on February 11 began review of these reports in Oak Ridge, Tenn. It is anticipated that the review can be completed in 8 to 10 weeks. Publication of the most useful declassified documents will follow as rapidly as possible.

One major impact of further declassification will be the bringing into the open literature of the technology necessary to frame nuclear engineering courses in colleges and nuclear science units for use in high-school courses; to prepare many textbooks and technical manuals and reports for issuance by the commercial publishing world and to carry on wider reporting in the professional and business press.

Commission programs for publishing and disseminating information

The major task just ahead for the Commission's information dissemination operation is the publication and issuance of the new volume of information declassified or downgraded under the new policies.

During the past year several steps were taken by the Commission to speed and widen the flow of technical information to science and industry generally and to make most useful the thousands of individual AEC documents reporting data and findings.

Standard distribution of reports released to the civilian application program.—In December 1956, access permit holders were offered the opportunity to request that the Commission send on an automatic basis all reports falling within the scope of any access permit. In order to receive technical information materials on an automatic basis, the permit holder now establishes an advance deposit account with the AEC, and is billed monthly for the publications provided to him.

Catalog card service.—Catalog cards on newly issued classified reports were made available for sale to access permit holders and cards on unclassified reports were made available for sale generally. The service of providing abstract journals and bibliographies was continued and expanded. The number of items abstracted in the Commission's unclassified journal, Nuclear Science Abstracts, was 12,194; in the 2 classified journals, 4,489; and 64 new bibliographies on industrial technology were issued during the year.

Model reference center.—A new reference service was added for industrial concerns which wish to send their own literature search teams to the Commission's Technical Information Service Extension at Oak Ridge. Available there are a complete collection of AEC-developed reports on industrial use, both classified and unclassified (40,000 in number—14,000 classified and 26,000 unclassified), a master card catalog, bibliographies, lists of available documents, and other reference aids.

Literature search service.—The Commission has arranged to provide to those desiring it a literature search service supplying on any sepcified topic either literature titles or, if it is requested, specific tabulated data. This service is provided to users at $6 per hour. It is expected to be particularly useful to small business concerns not possessing library resources.

Depository libraries.—During the year, 17 libraries in the United States were added to the 51 which were already supplied with a complete collection of the most useful unclassified publications of the Commission. There is now at least 1 library in each metropolitan area of 500,000 or more population in the United States. The Commission approved establishment of seven classified depository libraries located for the convenience of holders of access permits.

Preparation of books summarizing knowledge in individual industrial fields.—Provisions of standard and special reference tools to aid in using the report, journal article, and monographic technical literature is not enough. To fill in the gaps, and to help place the smaller firm on a more even footing with the larger corporation with extensive technical information services, it is necessary to compile the existing information into summary volumes surveying by fields the main bodies of data. This is not a new situation. Its existence earlier in the atomic energy program led to the Commission's National Nuclear Energy series of 29 classified and 35 unclassified compendia and monographs summing up the

technical knowledge developed by the work of the wartime Manhattan Engineer District; also to the preparation by individual authors under contract or by groups of contributors of unclassified texts in general and special fields such as the Sourcebook on Atomic Energy, Nuclear Reactor Engineering, Energy in the Future, and the 4 volumes of the Reactor Handbook.

To meet the need for new texts useful to industry based on the whole range of technical atomic literature, the Commission undertook an expanded program of writing summary volumes. Some are being prepared as a part of projects under reserach and development contracts, and some under specific contract with the firms which prepare engineering handbooks, and some with individual authors.

Now under preparation are 23 new volumes or revisions of existing volumes; 6 new volumes are to be contracted for in fiscal 1957; and 14 are planned for contracting in 1958. Additional volumes also will be prepared as an integral part of research and development contracts in the current and coming fiscal years.

Looking past 1958, the Commission staff, with the assistance of the Advisory Committee on Industrial Information, has compiled a list of more than 100 other summary volumes needed by industry. The Joint Committee has been supplied with the titles under preparation or to be contracted for in 1957 or later years.

No one of these contemplated volumes will be undertaken by the Commission if a commercial or academic technical publishing house indicates that it desires to prepare, publish, and sell such a volume on a time schedule consistent with the advancement of nuclear technology. Close contact is maintained so that the Commission will not enter areas which will be covered by private publishing houses.

Provision of current technical progress reviews covering major industrial fields.—No matter what speed and thoroughness are put into private publishing and the Commission contract book preparation, the published works can hardly be kept sufficiently current to meet the needs of the developing atomic energy industry. Therefore, a completely new program is being undertaken in fiscal year 1957. This is the preparation and issuance of current Technical Progress Reviews in specific subject matter areas. These reviews will digest the latest findings in technology and science. In other words, there will be a number of summary-type topical reports issued each year to keep industry abreast of the new things in technology and science coming out of the Commission-financed development programs and—so far as possible—the industry-financed programs. The areas to be covered by the reviews have been reported the committee.

Classified and unclassified sale of Commission technical reports.—During the year more than 19,000 classified reports were furnished to access permit holders who had completed all security requirements. The average monthly dollar volume of sales distribution was $1,260.

Commission unclassified technical reports may be purchased from the Office of Technical Services, Department of Commerce. An indication of public demand for such reports is shown in the sales volume of 128,000 copies recorded by the Office of Technical Services during 1956, compared with 80,000 in 1955. Sales of unclassified AEC reports in microcard form by the Microcard Foundation reached 200,000 copies in 1956, compared to 50,000 in 1955.

Use of information services, Government and non-Government, by industry.—The Commission has engaged McKinsey & Company, Inc., management consultants, to conduct a survey of all access permit holders to obtain their appraisal of the effectiveness of the Government and non-Government technical information services available to them. The final report will be submitted to the Commission later this month and will be provided to the committee

REVIEW OF THE ACCESS PERMIT PROGRAM

The program for making available to private enterprise classified scientific and technical information relating to the civilian uses of atomic energy was established in April 1955. Its purpose is to provide a simple and direct procedure to enable private individuals and organizations to learn more about atomic-energy technology and to assess or develop their potential role in the new industry. As their technical knowledge increased they would be better prepared to pursue their specific interests, whether in research and development, the design, construction and operation of nuclear facilities, or as suppliers of materials and services. The large mass of unclassified information already

available was thus supplemented with classified technical reports and data previously limited to the Commission and its contractors.

Commission policy is directed toward steadily enlarging the fields of unclassified data. The new classification policies adopted in December will bring numerous fields—ranging from uranium production to chemical processing of spent reactor fuels—into the open literature. As the reports and books are published or otherwise made available, the need of industrialists to obtain information through access permits will correspondingly decrease. There will remain however certain areas of information of industrial interest use of which can be obtained only through access permits.

The access program has now been in effect for almost 2 years. In that period 1,258 applications for access permits have been received and 1,156 permits issued. Eleven permits have been terminated at the request of the permittees leaving a total of 1,145 in effect at the start of 1957. Of these 566 give access to information classified secret as compared to 172 at the start of 1956. New applications are being received at an average of 40 per month. Tables I through V attached to this section show the distribution of permit holders by industry and occupation, size of organization, fields of interest, and geographic area. Virtually every major segment of the Nation's industrial complex is represented in the list of permit holders In addition, other organizations such as educational institutions, labor unions, trade associations, and public bodies are included.

As might be expected over half (62 percent) of the outstanding permits are held by firms and individuals in the heavily industrialized areas of the North Central and Middle Atlantic States. Roughly, one-third of all permit holders are in the metals and chemicals industries.

As for field of interest, 34 percent are interested in the manufacture of reactors and components for the production of atomic-energy products and 29 percent in the operation of reactors, chemical processing, and ore refining. During the past year the number of small businesses (companies employing 500 or less) requesting access permits has more than doubled. At the start of 1957, more than 53 percent of all access permits were held by small business.

These statistics provide a good indication of the wide range of industrial interest in the civilian uses of atomic energy. The extent to which holders have put their permits to use is indicated by the fact that as of December 31, 1956, permittees had obtained 5,556 new security clearances for access to confidential information and 4,237 new clearances for access to secret categories in the civilian application program. These new clearances of course are in addition to reaffirmations and extensions of previously existing clearances which total 1,787 for access to confidential and 5,462 for access to secret restricted data.

Technical assistance meetings and visits

The services available to industry under the access program are not limited to the furnishing of technical reports and documents. Individuals and firms may avail themselves of discussions and consultations with the Commission's and contractors' technical staffs and participate in technical information meetings arranged by the Commission. These services make available to interested firms the advantages of informal and extended discussion of their problems with technical specialists. They are also a valuable complement to the printed reports and enable the firms to obtain the most current technology applicable to their particular projects.

During 1956 many visits were made by access permittees to AEC installations for classified technical discussions. This service is important as a means of access to the latest technical data, for the explanation or interpretation of published information which is of particular importance to specific persons or groups, and as a means of dissemination of specific detailed information which is not of sufficiently general interest to warrant publication. Such visits are arranged to the maximum extent consistent with AEC's own program requirements.

Meetings

During 1956 growing emphasis was placed on general meetings covering rather wide areas of subject matter at which access permit holders received and discussed among themselves classified information in the various fields. Six such meetings were held in 1956 on a classified basis. Three already are planned for 1957. These nine include the following:

Subject	Date	Approximate industry attendance
Industrial supply of feed material	Jan. 12-13, 1956, Cincinnati	85
Homogeneous reactor experiment	Mar. 21-22, 1956, Oak Ridge	225
Radiation effects	July 31-Aug. 2, 1956, Argonne	198
Cold processing of enriched uranium	Sept. 13-15, 1956, Oak Ridge	123
Sodium reactor and organic moderated reactor experiments.	Nov. 8-9, 1956, Los Angeles	250
Uranium-magnesium fluoride slag recovery	Dec. 6-7, 1956, St. Louis	88
Isotopic analysis of uranium	Feb. 5-7, 1957, Chicago	
Sherwood project	Feb. 20-23, 1957, Berkeley	
Accountability for SNM	Mar. 5-7, 1957, New York	

Indicative of the trend under the new classification policies toward more dissemination of unclassified information, three additional meetings already are planned for 1957 on an unclassified basis—open to access permit holders, of course, but also to any interested person who has not obtained access to restricted data. This list includes a meeting on boiling water reactors; one on nuclear safety and one on fast reactors.

These meetings bring together representatives of industrial organizations who desire to familiarize themselves with current technology in selected areas of present or potential interest to them. The meetings are arranged either as the Commission identifies particular areas of technology or manufacturing processes that are believed to be of present interest or as numbers of inquiries are received to indicate industry's interest in a given field.

In addition to the meetings listed above the Commission's program divisions also held a number of meetings of more limited interest on a variety of specific projects. Proceedings of all industrial information meetings are made available not only to those attending, but to others interested who possess the appropriate security clearance if any is required.

MORE CLASSIFIED INFORMATION MADE AVAILABLE

During the past year the Commission has continued to give attention to the expansion of the areas of classified scientific and technical information available to holders of access permits. One new category of classified information was added to the 27 categories previously available. This additional category covered secret restricted data on controlled thermonuclear processes. Access to restricted data in this category is authorized for organizations showing a need and meeting the following criteria:

1. That the applicant is engaged in a substantial effort to develop, design, build or operate a fission power reactor that is planned for construction; or
2. That the applicant possesses qualifications demonstrating that he is capable of making a significant contribution to research and development in the controlled thermonuclear field.

The wide range of industrial interest in the technology available under the access program has been fully demonstrated in the almost 2 years of the program's operation. As organizations become more familiar with the information of interest to their special fields and proceed to the more advanced stages of their projects, new needs will doubtless develop. It will be the Commission's purpose further to expand its services to meet their needs.

SAFETY EDUCATION AND TRAINING

The increased participation in fuel manufacturing and handling, the use of isotopes, and operation of reactors, has been accompanied by accelerated interest in safety education and training. To meet the demands coming from prospective and actual users and from insurance companies and sometimes from other Government agencies, safety training aids which translate the experience in AEC contractor plants have been prepared. A radiation booklet in simple language (Radiation Safety Primer) for training employees has been published, supplemented by an instructor's handbook and 46 color slides, all of which are available to civilian users. Especially designed for firemen and fire-control officers, a pamphlet Radiation Hazards in Fire Fighting was published and has sold over 4,000 copies. The Commission has also cooperated with the National Fire Protection Association and fire insurance groups in the publication of pamphlets

for fire protection in radiation laboratories, in reactors, and in particle accelerators. Films have been made on the toxicity of uranium and uranium-zirconium alloy surface explosions; a narrated film on the safety measures involved in the Chalk River reactor incident in Canada is in production. Information on accidents as they occur involving the special hazards encountered in plants of Commission contractors are published and are available to the industry.

A plan is being worked out to offer instruction to fire chiefs, State fire marshals, and fire college instructors in problems related to fire fighting in nuclear energy plants which can be transmitted to fire department personnel.

Because of wide interest in current research and experience with explosions involving zirconium, thorium, and other pyrophoric metals, meetings of manufacturers and research personnel have been held in Washington and Pittsburgh; additional meetings are planned in early 1957 further to disseminate knowledge of developing technology to prevent explosions.

TABLE I.—*Business or occupation of access permit holders*

	Reported in previous testimony as of Dec. 31, 1955	As of Dec. 31, 1956
Aircraft companies [1]		11
Auto manufacturers [1]		3
Chemical processing	56	[2] 97
Consultants	56	[3] 175
Educational institutions [1]		20
Engineering and construction	57	70
Federal, State and city governments and departments [1]		43
Financial organizations	42	[4] 20
Food companies [1]		3
Information and education	21	[5]
Information services [1]		13
Instrument manufacturing	42	70
Insurance companies [1]		64
Lawyers and accountants [1]		25
Metal mining and refining	21	60
Metal products manufacturing	107	189
Paper and pulp companies [1]		4
Petroleum companies [1]		20
Printing and publishers [1]		9
Railroad companies [1]		5
Research organizations	30	50
Rubber companies [1]		5
Shipbuilders [1]		9
Utilities	132	151
Unions, trade associations, and manufacturers' representatives [1]		12
All others not elsewhere classified	38	17
Total	602	1,145

[1] A new classification. Some of the permit holders reported in this classification in 1956 were reported in other more generalized classifications in use during 1955.
[2] Excludes petroleum companies now classified separately.
[3] Excludes lawyers and accountants now classified separately.
[4] Excludes insurance companies now classified separately.
[5] This classification has been discontinued in favor of separate classifications for "Educational institutions" and "Information services."

TABLE II.—*Access permit holders by field of interest*

	As of Dec. 31, 1955	As of Dec. 31, 1956
Operating atomic facilities:		
Reactors for production of electric power	133	168
Reactors for other purposes, such as research, propulsion of ships, etc	28	47
Plants to refine uranium and thorium ore and process-feed materials	39	76
Chemical plants for reprocessing spent fuel elements	21	46
Manufacture of atomic-energy products:		
Entire reactors	40	100
Components, such as fuel elements, instruments, and pumps for reactors and related facilities	123	241
Materials for atomic-energy applications such as zirconium, carbon, and special alloys	49	121
Related activities:		
Utilizing radioactive isotopes for sterilization of food, radiochemistry research, etc	38	57
Design and construction of atomic-energy facilities	56	79
General nuclear research	28	50
Consulting on atomic-energy problems	54	172
Investing and lending capital	16	20
Evaluating insurance risks	27	59
Others not elsewhere classified	[1] 63	136

[1] Since the 1955 report, the classifications for "Waste disposal," "Regulation of utilities," and "Publishing and advertising" were discontinued and the figures included in "Others not elsewhere classified."

NOTE.—These figures include permit holders with more than one field of interest, resulting in a total greater than the number of permittees.

TABLE III.—*Access permit holders by number of employees*

	As of Dec. 31, 1955	As of Dec. 31, 1956
Number of employees:		
0 to 10	87	234
11 to 100	81	191
101 to 500	95	191
Subtotal for small business	263	616
501 to 2,000	135	208
2,001 to 10,000	125	190
10,001 to 50,000	59	86
Over 50,000	12	24
Not given	8	21
Subtotal for large business	339	529
Total	602	1,145

TABLE IV.—*Access permit holders by geographic areas* [1]

	As of Dec. 31, 1955	As of Dec. 31, 1956
New England	57	103
Middle Atlantic	225	413
East North Central	118	234
West North Central	41	72
South Atlantic	60	115
East South Central	9	25
West South Central	23	40
Mountain	16	37
Pacific	50	102
Hawaii, Alaska, and Puerto Rico	3	4
Total	602	1,145

[1] Standard Department of Commerce areas.

TABLE V.—*Number of permittees having access to secret restricted data by categories*

Categories	*As of Dec. 31, 1956*
Chemistry, general	311
Chemistry, radiation and radiochemistry	359
Chemistry, separation processes for plutonium and uranium	302
Chemistry, transuranic elements	195
Controlled thermonuclear processes	74
Experimental biology and medicine	1
Geology and mineralogy	10
Isotype separation	43
Metallurgy and ceramics	402
Metallurgy, raw materials	236
Particle accelerators and high-voltage machines	106
Physics and mathematics	348
Instrumentation	356
Radiation effects on reactor materials	384
Health and safety	389
Reactors, production	245
Criticality hazards	296
Technology, feed materials	216
Technology, plutonium	202
Technology, tritium	40
Hanford, fuel element technology	1
Hanford, reactor technology	1
Hanford, separations process technology	2
Radioactive waste	383
Savannah River, fuel element technology	1
Savannah River, reactor technology	
Savannah River, separations process technology	2
Reactors, research and testing	363
Reactors, power	423

V. MANPOWER BASE FOR THE ATOMIC ENERGY INDUSTRY

When the Commission appeared at these hearings last year, Dr. Libby and others dealt with the critical shortage of skilled manpower in atomic energy and other fields. They made the point that shortage of engineers and scientists threatened to become a serious limitation on atomic industrial development.

This condition, as they pointed out, prevails for other lines of industrial development. One of the Nation's major problems for the future is to assure that enough men and women adequately trained in engineering and the sciences are available to support the needed growth in products and services.

During the past year increasing attention and efforts have been devoted by government and professional committees and agencies, educational institutions, industrial and business concerns, and others toward increasing the number and improving the quality of scientists and engineers. There are indications that the supply of newly graduated scientific and technical manpower, which has declined in the United States since 1950, is turning upward once again.

However, despite an improving picture, the shortage of scientific and technical manpower is of serious concern to the Nation and will continue to be serious for years to come. For example, the number of first degrees in engineering conferred by accredited institutions declined from 48,160 in 1950 to 19,707 in 1954 but rose to 23,547 in 1956. These data may be contrasted with the estimate of the Engineering Manpower Commission that the 1955 need was for approximately 35,000 new engineers a year and that the need will accelerate annually by 3,000 to 4,000 for the next several years. The number of first degrees in the physical and biological sciences decreased in like proportion with engineering—from 46,102 in 1950 to 23,336 in 1954. The statistics for later years are not yet in hand.

The fact which gives most concern about the decline in the first half of the 1950's is that the proportion of engineering and science graduates to the total

number also declined. The science and engineering graduates of 1950 were nearly 22 percent of the total graduates; those of 1954 were only 15 percent of the total.

In no area of our economy is the technical manpower problem of any greater import than in the developing atomic-energy industry. The growth of this industry depends upon an adequate supply of manpower trained in a wide variety of professional skills. More than half of the technical men engaged in Commission programs are engineers, drawn from every field of engineering; one-third are physical scientists, mostly chemists and physicists; the remainder are specialists in biology, medicine, and other life sciences.

Expanding activities in peaceful uses of atomic energy will exert a continuing major influence on the demand for technical manpower. As the joint committee's Subcommittee on Research and Development recognized in its report after extensive hearings last April on the manpower shortage, the demands of the atomic-energy industry can best be met by efforts to increase the total supply of competent and qualified graduates in the scientific and engineering disciplines. The scientists and engineers needed in the atomic-energy industry are persons with well-rounded basic training who will best learn at the graduate level how to modify or adjust the normal practices of their respective specialties to the changing technology of an atomic age.

SURVEYS OF MANPOWER NEEDS

The first step toward assuring an adequate supply of trained men for the atomic industry of the future is to find out the probable size of the demand. We know generally that demands for manpower trained in nuclear disciplines are numerous and increasing among Commission contractors; among the armed services and civilian agencies of Government; among colleges, universities, and nonprofit organizations for education and research; and among privately supported atomic-energy industries.

The Commission considers it essential to make estimates of future manpower demand broad enough to include the individual interests of all groups participating in atomic-energy activities. For this purpose, the Commission during the past year has undertaken a four-part survey program designed to provide information regarding the demand for engineers and scientists:

(*a*) The Atomic Industrial Forum, under contract with the Commission, is gathering data regarding the scientific and technical manpower needs of industries;

(*b*) The Commission's staff is gathering data regarding its own and contractor requirements;

(*c*) The Commission's staff also is gathering data on the manpower requirements for other Government agencies in or entering the atomic energy field;

(*d*) The American Society for Engineering Education has been requested to gather data with respect to college, university, and nonprofit organization manpower requirements in the atomic energy field; a contract for this study is now being negotiated.

Data from this survey program will permit comprehensive analyses of the demand for technical and scientific manpower in atomic energy. Summaries of all the survey data will be provided to the committee as soon as the responses have been received and analyzed.

The Atomic Energy Commission is not awaiting the results of the studies before moving ahead with various programs in education and training to serve the obvious needs. Some of these programs were reported to the Joint Committee in the section 202 hearings of 1956; others have been started since and were reported to the committee as they were undertaken.

TRAINING AND STUDY PROGRAMS BY INDUSTRY

There are many indications that industry, educational institutions, and other Government agencies recognize the critical importance of time and are also taking similar steps. The Commission recently completed an inventory of the extent and kinds of training and education being offered by its contractors. The results of this inventory are summarized below:

AEC contractor educational and training activities, 1956

Participants:	
Total number	[1] 13,940
Source (percent of total participants):	
AEC contractors	69
Other industry	10
University faculty	9
University students	6
Government	6
Subject matter (percent of total participants):	
Reactor technology	38
Nuclear science and engineering	29
Health and safety	9
Nuclear materials	8
Radioisotopes	6
Radiobiology	5
Nuclear fuels	3
Radiation and isotopes in medicine	2

[1] About 3,000 more individuals participated in programs not identified above. Further, interest in atomic energy at secondary schools was stimulated through the use of guided tours, guest speakers, exhibits, films, and pamphlets. For example, from July 1955 to July 1956 well over 300 speeches were made to secondary school audiences by Commission contractor personnel.

There are available no reliable comprehensive data concerning the current training programs of industry, educational institutions, and all Government agencies. It is estimated, however, that during the 1955–56 academic year there were about 200 college students majoring in nuclear engineering; in 1956–57 about 600; and in 1957–58 there will be about 1,200.

Some industrial firms and private groups are planning and conducting educational programs for their own staffs within their own facilities. Other firms have developed cooperative programs of study with educational institutions. For instance, it has been reported that under special arrangements General Electric Co. personnel are being trained at Rensselaer Polytechnic Institute, and Ebasco Services personnel at Columbia University. A short course in reactor materials is offered by the Atomic Industrial Forum at Northwestern University and New York University.

It is significant also that educational and training programs for industrial personnel in the atomic energy field are not limited to professional engineers and scientists. Millwright, pipefitter, and boilermaker unions have secured AEC access permits and have designated some of their members to study the impact of the atomic energy industry on their crafts. These studies are leading to revisions in programs for apprentices, to fit them for the requirements of the nuclear energy industry.

TRAINING AND STUDY PROGRAMS BY AEC

Some of the Commission's educational and training programs were reported in previous hearings, and others have been reported in the 20th and 21st semiannual reports. It has been pointed out earlier in this testimony that the Commission's declassification action in November 1956, will lead to the declassification of a large amount of information which will go far toward enabling industry to design, construct, and operate civilian power reactors on an unclassified basis; and that curricula and texts covering the field may now be prepared.

The AEC's program of assistance to United States colleges and universities is designed to help them carry a substantial student load for education and training in nuclear energy technology.

The educational and training programs which the Commission is currently supporting are as follows:

Special graduate schools

Oak Ridge School of Reactor Technology.—Since 1950–51, ORSORT has graduated from its 1-year course, 469 students, sponsored by American industries and Government agencies. The student load was increased from 90 to 118 students during the 1956-57 school year. A cooperative arrangement with 6 American

colleges and universities, under which they will give the first half of the course of study, will increase the number of graduating students to about 240 during 1957–58.

International School of Nuclear Science and Engineering.—In 1955 this school was established at Argonne National Laboratory to help carry out the intent of the President's atoms for peace program and has graduated 162 students from its 1-year course. Of these students, 116 were foreign nationals from 34 countries, and 46 were from the United States. In April 1956, the school's program was expanded to provide cooperative participation by 2 colleges and universities, both of which have nuclear reactors. This cooperative program will permit the International School to double its annual capacity from 60 to 120 students.

Oak Ridge Institute of Nuclear Studies.—This organization is a nonprofit educational corporation involving 35 southern universities which carries on the following special training work under its contract with the Commission:

Resident graduate program: Employees of AEC contractors at Oak Ridge constitute the majority of students enrolled in the formalized courses of instruction offered under this program. Approximately 1,250 students have been enrolled of whom 33 have received their master's degrees and 34 have received their doctorates.

Oak Ridge graduate program: Selected graduate students who have completed all formalized course work and other university requirements, except for the theses, have the unique opportunity of utilizing the specialized equipment and working with the personnel at Oak Ridge National Laboratory in performing their research projects for theses requirements; 54 fellows have conducted research at ORNL; 7 master's candidates, and 31 doctoral candidates have been granted degrees by their sponsoring universities.

Research participation program: University scientists are provided the opportunity to conduct research for periods of 3 or more months at Oak Ridge National Laboratory, University of Tennessee-AEC Farm, or ORINS; 486 faculty members have participated, and 73 are in the 1956–57 program.

Clinical training program: Resident and postresident physicians, medical students, basic science trainees, research participants, and others may obtain specialized training in the use of atomic energy. A total of 155 individuals have received training in the clinical program.

Radioisotope training program: A variety of short training courses in the safe use and handling of radiosotopes in research are offered. Courses of from 1 to 5 weeks have been given to more than 2,800 participants.

AEC special fellowship programs

Special fellowships in nuclear-energy technology.—This program, started in the past year, provides 1 year of graduate study for 150 fellows annually in accredited colleges of engineering. The first fellows are now being selected for the 1957–58 academic year.

Special fellowships in radiological physics.—Selected college graduates with degrees in basic science or engineering spend an academic year at Rochester (Kansas), Washington (Seattle, Wash.), or Vanderbilt Universities and then go directly to a Commission laboratory for 3 months of practical experience. The program has had 275 participants, and 69 fellows have been appointed for the 1956–57 academic year.

Special fellowships in industrial hygiene.—Nine months of graduate training is provided for selected graduates in basic science and engineering at Harvard University's School of Public Health or the University of Pittsburgh's Graduate School of Public Health. The program has had 30 participants, and 9 fellows have been selected from 44 applicants for 1956–57.

Special fellowships in industrial medicine.—Physicians receive 1 year of advanced academic training at Harvard, Pittsburgh, Cincinnati, or Rochester University, after which the fellows may take an additional year of work at a Commission laboratory. The program has had 32 participants, and 7 fellows have been appointed for 1956–57.

Graduate-student research training.—An important result of AEC's contracts with more than 204 colleges and universities for the conduct of work in the fields of basic research, biology and medicine, reactor development and raw materials, is not only that the Commission receives the results of research by highly qualified scientists, but also students who are associated with the projects receive valuable training through their participation in the research. It is estimated that about 1,600 students in 1956 received research training through their association with the research projects which are supported by the Com-

mission. In addition, the Commission cooperates with the Office of Naval Research in a joint program of basic research in nuclear physics, and it is estimated that an additional 450 students receive training in research methods through association with these projects.

Faculty training

One of the problems faced by colleges of engineering in inaugurating courses of study in nuclear-energy technology has been the lack of faculty specially trained in nuclear science and engineering. The Commission is assisting the colleges with the following programs:

Summer institutes for engineering faculty.—This project was started within the past year in cooperation with the National Science Foundation. Last summer two institutes in nuclear reactor technology were conducted for engineering faculty members. Both were of 60 days' duration. The institute at Argonne National Laboratory had 60 participants and the one at Brookhaven National Laboratory had 30 participants.

Summer research for university faculty.—During the summer months of 1956 an additional 285 universal faculty members participated in research programs at Commission laboratories.

Conference on engineering education and nuclear energy technology.—The Commission sponsored and conducted a conference at Gatlinburg, Tenn., September 5–8, 1956, for deans of engineering and presidents of universities which have accredited colleges of engineering. The purpose of the conference was to discuss problems of engineering education related to nuclear-energy technology. The conference was attended by 293 educators representing 151 educational institutions.

On-the-job training

Industrial employee training.—American industries may send their employees to Commission facilities to participate in assigned work tasks. The industrial employees remain on the payrolls of their sponsoring companies but are subject to all the rules and regulations of the AEC contractor. The industries benefit through the training received by the employees. In 1955, 38 industrial engineers and scientists participated in this program; 65 took part in 1956. To date, employees of 53 industrial firms have participated.

Engineering practice schools.—Graduate students are provided practical education through the application of basic fundamentals to technical problems in research, design, development, and production. The Oak Ridge National Laboratory cooperates with the Massachusetts Institute of Technology in this program. There have been 150 graduate student participants in this program.

Summer employment.—The Commission's facilities provide summer employment for undergraduate and graduate students and for faculty.

High-school programs

To help enlist interest in careers in science and engineering, the Commission has established the following programs for aiding high schools in science teaching:

Radiobiology training for high-school science teachers.—Inaugurated in 1956, this program is carried on in cooperation with the National Science Foundation through summer courses which emphasize the utilization of radioisotopes. During the summer of 1956, courses were conducted at Harvard University, Duke University, and the University of New Mexico for 60 high-school science teachers. The Commission provided each teacher with a radioisotope demonstration kit to be used in his school for instructional purposes. In the summer of 1957 this program will be offered at the 3 universities mentioned above and at 2 others—Wayne State University and University of California at Los Angeles.

Science demonstration lecture program.—This program also was inaugurated in the summer of 1956 in cooperation with the National Science Foundation, when a selected group of 8 high-school science teachers spent the summer in training at the Oak Ridge Institute of Nuclear Studies. Each teacher was then provided with science demonstration equipment. The 8 teachers will visit more than 200 high schools in all 48 States and the District of Columbia for science demonstrations and lectures to students during the school year 1956–57.

Secondary-school science teachers' institutes.—These are conducted at Oak Ridge Institute of Nuclear Studies in cooperation with the National Science Foundation. During the summer of 1956, 2 institutes were conducted with 96 participants.

Science fair program.—This program is conducted by the Oak Ridge Institute of Nuclear Studies also with the objective of encouraging elementary- and secondary-school student interest in science as a career. The program was inaugurated in 1954 and 18 work conferences have been held. These have resulted in more than 800 new science fairs being organized.

Other assistance available to educational institutions from AEC

In addition to the programs described above for training both students and faculty members, AEC also provides material assistance to institutions in providing necessary tools of research and equipment. Programs in this area include:

Research reactors.—The AEC provides material assistance to nonprofit educational and medical institutions in the operation of research reactors. At present, North Carolina State College, Pennsylvania State University, and the University of Michigan have received such assistance. The current program of assistance consists of furnishing fuels and heavy water free of cost, providing funds and services for fabrication of fuel elements, reprocessing fuel elements, and furnishing neutron sources free of cost.

Assistance to colleges and universities with equipment and teaching aids.—This program was inaugurated during the past year. Under it the Commission provides assistance to nonprofit educational institutions in acquiring training reactors, teaching aids, demonstration apparatus, laboratory equipment, and certain nuclear materials to be used primarily for educational and training purposes in nuclear-technology courses. Assistance is not given for construction of buildings and utility systems, for overhead expenses, or for personal services. A sum of $3,400,000 was provided by Congress for this program in fiscal year 1957. The program was inaugurated in September 1956, and, up to January 1957, 46 proposals for assistance had been received from colleges and universities. The Commission's staff is currently evaluating the proposals and expects to announce grants in the near future. It is estimated that about 60 educational institutions will receive assistance for equipment and materials in 1957.

To date the Commission has approved uranium fuel and neutron sources for 16 subcritical reactors at educational institutions and is evaluating 10 additional proposals. Colleges and universities for which subcritical reactors have been approved are: Alabama Polytechnic Institute, City College of the City of New York, Cornell University, University of Florida, Georgia Institute of Technology, Iowa State College, University of Maryland, Massachusetts Institute of Technology, New York University, North Carolina State College of Agriculture and Engineering, the Ohio State University, Reed College, Rensselaer Polytechnic Institute, Stanford University, Virginia Polytechnic Institute, and Yale University.

The objective of this program of providing equipment and teaching aids is to assist educational institutions in inaugurating nuclear science and engineering curriculumns at the graduate level, with the hope that the colleges and universities will be able to give postgraduate education and training in nuclear science and engineering to sufficient numbers of students to make a substantial contribution to the total needs for such persons.

VI. Supplying a Developing Atomic Energy Industry

The Commission's procurement experience indicates a rapid increase in the number of industrial firms seeking to supply equipment and materials for nuclear research, development, and application projects. This general impression is supported by the Buyers Guide section of the November 1956 issue of Nucleonics, an industrial magazine devoted to reporting for the new nuclear industry. That issue lists 1,591 firms offering for sale products useful in these fields. The classifications of products extend from Absorbers—Radiation and Accelerators—Particle to Zinc Bromide, a substance used for shielding windows in atomic plants and laboratories.

However, in the transition from the Government monopoly in atomic energy matters to a competitive private enterprise there are areas in which the Commission must take the initiative or give direct support to the development of industrial sources for certain products and services. There are other areas in which the Commission must itself supply needed materials or services until the growth of industrial usage permits private capital to provide them.

Preparation of materials by industrial suppliers

One effective means of creating private industrial capacity is for AEC to procure some materials and services required for its own operations from industrial sources thus providing a base load justifying plant capacity and development effort which the embryonic atomic energy industry could not support alone for several years. The development of new or improved processing methods by bringing concentrated industrial effort to bear on particular processing operations is another objective. Steps along this line taken by the Commission during 1956 have included:

AEC procurement of uranium hexafluoride from industrial suppliers.—Invitations were issued on October 27, 1955, requesting proposals for supplying refined uranium compounds produced in privately owned and operated facilities. Seven proposals were received by October 1, 1956, the final date for their submission. The proposal submitted by general chemical division of Allied Chemical & Dye Corp. was selected as a basis for further negotiation. This proposal provides for the processing of uranium concentrate, to be supplied by the Commission, to uranium hexafluoride in an amount equivalent to 5,000 tons of U_3O_8 annually for 5 years. The basis for selection of the Allied proposal was that it offered the desired quantity of material at the lowest overall cost to the Government.[2]

A letter contract with Allied was executed on December 5, 1956. The plant is to be located in the Ohio Valley at a site yet to be selected by Allied. Under the terms of the contract, it is to be in operation by April 1, 1959. Design work has been initiated by Allied.

Proposed recovery by industry of uranium from AEC magnesium fluoride slag.—On November 2, 1956, the Commission invited proposals for the purchase of magnesium fluoride slag, containing 1 to 5 percent uranium, and for resale to the Commission of the recovered uranium. Proposals are to be submitted by April 1, 1957.

Under the program, which was first announced on January 17, 1956, 4,000 tons of slag will be sold annually for 5 years beginning as early as July 1, 1958, at a price to be established by the competitive proposals. The magnesium and fluorine content of the slag will remain the property of the buyer.

The uranium is to be returned to the Commission either as: (1) a concentrate-type material, suitable for feed to the AEC's uranium refining process, or; (2) uranium hexafluoride. Since the original announcement of this program some 80 firms have expressed an interest in participating. A technical information meeting to which these firms, as well as all access permit holders, were invited was held in St. Louis, December 6, 1956. Thirty-six firms were represented at this meeting.

Progress toward establishment of industrial facilities to convert enriched uranium hexafluoride to forms required for fuel elements, fabricating fuel elements, and recovering scrap from fuel element fabrication

Processing of UF_6.—An information meeting on the processing of "cold" (i. e., unirradiated) enriched uranium held in Oak Ridge during September 1956, was primarily oriented to the technology currently being used in Commission processing plants. In addition, attention was devoted to new developments. A large number of organizations attended the meeting and the tours of the production facilities at Oak Ridge and Fernald. Mallinckrodt Chemical Works has established new commercial facilities for the conversion of uranium hexafluoride to other uranium compounds. The plant is now processing normal and enriched uranium and uranium compounds. It also processes the uranium scrap from its own operations. This plant is the first commercial facility with the ability to convert uranium hexafluoride to other forms. Other firms have indicated intention to provide similar facilities.

Fabricating fuel elements.—An increased number of firms is actively engaged in processing uranium or uranium compounds into fuel elements. The availability of fuel element fabrication services from industry has made it possible for the Commission to withdraw almost completely from this activity as far as private projects are concerned and to procure some of its own processing and fabrication services commercially on terms advantageous to the Government. Several recent contracts for the manufacture of fuel elements for the Commission have been awarded on the basis of competitive fixed price bids.

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[2] The process to be employed by Allied differs from that currently used in Commission facilities. Initial investigation of the unique features of the processes had been carried out in Commission laboratories and the results were made available under the access-permit program.

Several developments involving the fabrication of reactor fuel elements in private industrial facilities indicate the growth of the industry in this field.

Aero Jet-General Nucleonics is fabricating core assemblies for its own research reactors.

Atomics International Division of North American Aviation plans to fabricate the fuel for its reactors.

The Babcock & Wilcox Co. has undertaken the fabrication of fuel elements using uranium enriched to 20 percent uranium 235 for several foreign reactors. The first control rod elements for the Netherlands reactor are scheduled for delivery early in 1957 and manufacture of the elements for reactors for Brazil and West Germany has been undertaken. The entry of private industry into the manufacture of fuel elemenets from uranium enriched to 20 percent uranium 235 marks a significant step. Previously the Commission had been the only source of such elements and the manufacture of satisfactory elements of this isotopic assay has been regarded as a difficult operation. This firm, too, has completed the manufacture and delivery, under contract, of materials testing reactor fuel elements and is engaged in supplying fuel elements for the engineering test reactor, Livermore pool-type reactor, and one of the military reactors. It has made the fuel assembly for the critical experiment in connection with the Consolidated Edison reactor and expects to manufacture the fuel elements for that reactor.

Combustion Engineering, Inc., and Olin-Mathieson Chemical Co., have undertaken the manufacture of fuel elements for certain military reactors.

The General Electric Co., in its metallurgical products department and atomic power equipment department, is preparing for the manufacture of fuel elements for military and both domestic and foreign reactors.

The Mallinckrodt Chemical Works is preparing for production of the uranyl sulfate solution type fuel for reactors for Japan and Denmark.

Glenn L. Martin Co., plans to make the fuel elements for its own reactors and for others.

Metals & Controls, Inc., fabricated the fuel elements for the Battelle reactor and is doing other fuel fabrication work on military reactors.

Nuclear Metals, Inc., has produced the second core for the Argonne CP–5 and is engaged in fabrication of fuel for military reactors.

Sylvania Electric Products, Inc. is manufacturing fuel elements for Atomic Energy of Canada, Ltd., in addition to fabrication work for the Commission.

The Westinghouse Electric Corp., through its commercial atomic power division and Blairsville metals plant, is manufacturing certain military reactor fuel elements and plans other fuel element fabrication for both domestic and foreign reactors.

AMF Atomics is establishing a facility in Canada for the manufacture of fuel elements. Current plans involve work for AECL and the effect of current limitations on ownership and export of special nuclear materials are being investigated by that company to determine their effect on the ability of the company to provide similar services in connection with Commission and other United States and foreign reactors.

This brief summary does not reflect the entire growth of activities in performing intermediate fabrication steps and, in view of the growth of the industry, it is undoubtedly incomplete in reflecting the complete capabilities of industry for producing finished fuel.

Scrap processing.—Several firms have indicated interest in constructing and operating commercial facilities to process uranium scrap resulting from the commercial fabrication of reactor fuel elements. A survey is being made by the Commission of its enriched uranium scrap to determine whether some quantities may be offered to industry to supplement scrap generated in the civilian program.

Zirconium and hafnium.—The chief use of zirconium metal today is as a structural cladding and core alloying material for reactors. Hafnium which is useful for control rods in reactors, can be obtained as a byproduct from zirconium production. In May 1956 the Commission announced an expanded program to procure zirconium sponge. Long-range contracts have been signed with 3 new commercial suppliers for delivery of 2,200,000 pounds annually, of which about 80 percent will be used in naval operating units. National Distillers Products Corp., will supply 1 million pounds annually from new facilities to be built at Ashtabula, Ohio; NRC Metals Corp., a subsidiary of the National Research Corp., Cambridge, Mass., will supply 700,000 pounds annually from a plant to be constructed near Pensacola, Fla.; and Carborundum Metals Co., will supply 500,000 pounds annually from a plant being constructed at Parkersburg. W. Va.

Requirements for zirconium before these new plants go into production will be met by (1) production at a 325,000 pound annual rate from the Akron, N. Y., plant of Carborundum Metals Co., the only commercial supplier of reactor grade zirconium now in production in this country, (2) reactivating the Bureau of Mines pilot plant at Albany, Oreg., to produce about 300,000 pounds annually (the plant will be operated under contract by the Wah Chang Corporation of New York); and (3) importing 400,000 pounds from Japan during fiscal year 1957 under an arrangement made on behalf of the Commission by the Commodity Credit Corp.

Beryllium.—Beryllium is used in nuclear reactors primarily as a moderator and reflector. The only plant producing reactor grade beryllium has been the Commission plant at Luckey, Ohio, now operated by the Brush Berryllium Co. It is currently producing at a rate of approximately 43,500 pounds annually.

The Commission has recently signed separate contracts with the Brush Beryllium Co. and the Beryllium Corporation of America for 100,000 pounds of reactor-grade beryllium metal from each contractor annually over a 5-year period. Brush Beryllium Co. will build a new plant at Elmore, Ohio, and the Beryllium Corporation of America will build one near Reading, Pa.

Availability of AEC facilities and services for industrial use

To further assist private industry, public organizations, and nonprofit institutions in the formative years of their civilian application programs, the Commission provides, in its facilities, services which are not yet commercially available. This program involves services of two general types: processing services on source, special nuclear, and byproduct material, or other special materials, and nuclear research and development services.

Materials available from AEC.—The Commission continues to make available materials of the kinds and in the forms not currently available from industrial sources of supply, at the same time encouraging the development of such sources.

As noted in the testimony on the raw materials situation, natural uranium supplies are adequate to meet the foreseeable demands of defense or industry. Similarly, the Commission's ability to produce quantities of uranium 235 needed for both the presently known military demands and the forecast commercial demands of the next few years does not appear to place any limits on the progress of commercial development.

The general policy of the Commission in distributing source, special nuclear, and byproduct materials is to provide these materials in the form most readily available as the result of the Commission's normal operations with a minimum of special processing to make them suitable for commercial use. Thus the Commission relies upon industry to develop its own capability for further refining, processing, fabrication, and distribution, thereby minimizing demands on Commission facilities for these services. For example, the form in which the Commission prefers to furnish enriched uranium is uranium hexafluoride, the form withdrawn directly from the gaseous diffusion plants. The conversion of uranium hexafluoride to other forms such as metal, uranium oxide, or other uranium compounds is regarded as a processing service and is provided by the Commission only when the service is not commercially available. Charges for such services are determined for each application and are based on recovery of full cost to the Commission.

Enriched uranium is generally useful only in forms other than uranium hexafluoride and accordingly, much of the enriched uranium distributed so far has been converted by the Commission to those forms. However, as previously reported, at least one commercial firm now has entered this business and persons requesting such services from the Commission, therefore, must now show they cannot obtain the required service from private suppliers.

In addition to source and special nuclear materials, the Commission continues to make heavy water available for industry's use. Shipments for use outside of the United States totaled about 70 tons in 1956. Little demand, however, has developed in the United States. Studies concerning the cost and availability of upgrading and cleanup services for used heavy water are underway by the Commission. It is anticipated that the Commission will have to perform this service until the volume involved makes it profitable for the work to be done by private industry.

Chemical processing of spent reactor fuel elements.—The current projection of reactor fuel processing loads through fiscal year 1965, excluding those originating in production operations, indicate a continuously increasing volume of fuel to be processed, much of it from military reactors.

The reactor designs now under consideration for military and civilian power purposes involve fuel elements of many different chemical compositions and configurations. Practically all of the fuel elements require cladding or alloying materials other than aluminum, the only material for which an extensive processing technology has been developed. Consequently, the processing technology for these new reactor fuel types is still in varying stages of development.

Thus, a particularly important facet of the Commission's program for providing services relates to the processing of irradiated reactor fuels for recovery of their valuable constituents and disposal of the resultant radioactive wastes. While it has been and remains the hope of the Commission that this service, like all others required by the industry, will become available through private investment, technological and economic uncertainties—the foremost of which is the lack of an adequate commercial load until a sizable power reactor industry is in being—may make it difficult for such services to be established on a sound commercial basis at an early time.

In view of this possibility, the Commission has recently adopted a policy which will provide to reactor operators assurances that their fuel processing requirements will be provided for at firm, reasonable charges. Under this program, the Commission will, at the request of licensed reactor operators, enter into contracts to provide for processing services for reactor fuels for a term extending through June 30, 1967, at firm charges subject only to escalation on the basis of a price index. These charges will be based upon the Commission's full cost recovery pricing policy as applied to an assumed plant of nominal 1 ton per day capacity, capable of processing all the various types of power reactor fuels of current interest.

Consistent with the Commission's efforts to encourage private participation in the field of fuel processing, these contracts would be subject to termination by the Commission on 12 months' notice, in the event of a determination by the Commission that the required processing services will be commercially available at reasonable prices.

Meanwhile the Commission has continued efforts looking toward the entry of commercial firms in the chemical processing of irradiated fuel elements. Technical information meetings have been held for the purpose of making available to industry the technology developed and used by the Commission in the chemical processing of irradiated fuel elements and to acquaint industry with the problems involved and the development work underway in the Commission for the solution of those problems. To further encourage the establishment of industrial chemical processing facilities for irradiated fuel the Commission announced that certain Government-controlled irradiated fuels would be made available to provide a base load for commercial chemical processing facilities. Estimates of the types and quantities of these Government-controlled fuels which might be made available for chemical processing in commercial facilities over the next 10 years have been furnished to industry. It is hoped that these Government fuels will assist in providing a sufficient base load for a commercial chemical processing facility. In order that such services may be furnished by private industry at reasonable prices however, some difficult problems are involved.

Research and development services.—The Commission, on request, will perform specific research and development services for industry in Commission-owned facilities providing such services are not reasonably available from private sources and the proposed work will not interfere with the Commission's programs. A charge is made based on recovery of full cost to the Commission. Thus far, the bulk of the research and development services furnished by the AEC in response to specific requests has been in the fields of neutron and gamma ray irradiations.

The Commission is committed to furnishing a substantial amount of research and development services under the power demonstration reactor program as part of its contribution to certain civilian reactor projects. Additional effort of this type is anticipated as the pace of industrial participation increases in such fields as fuel preparaton and irradiated fuel processing.

The Commission has established as a policy that in providing materials or services which are generally available to the public, it will waive its rights to inventions or discoveries resulting from the use of such materials or services. At the present time, this waiver applies to most neutron and gamma irradiation services and to source, byproduct, and special nuclear materials distributed by the Commission in accordance with established price schedules.

VII. Some Aspects of Government Policy Affecting Atomic Industrial Development

AEC policy on prices and charges

Significance to industry.—The AEC policy on pricing materials and services which it makes available, and on establishing fair prices which it will pay for special nuclear materials produced in licensed facilities is recognized as being of major importance to the growth and development of the industry, both here and abroad.

The influence of these prices on the industry depends not only upon their actual level, but almost equally upon their stability, for without some assurance that these prices will remain reasonably stable, industry will be unable to make the long-range plans essential to the procurement of the financing necessary to proceed with its projects.

There has, accordingly, been no change in the basic pricing policy of the Commission which was described in testimony presented at last year's section 202 hearings. As before, this policy follows the criteria of the act with respect to nondiscrimination among users, reasonable compensation to the Government, encouragement of research and development, and avoidance of discouraging the development of sources of supply independent of the Commission.

Full cost of recovery policy.—For miscellaneous services and materials which the Commission must furnish in the absence of adequate commercial sources of supply, the Commission has continued to follow the policy of charging the full cost or a higher going commercial rate if appropriate to avoid discouraging the development of sources of supply independent of the Commission. The full costs applied by the Commission include direct and indirect operating expenses, depreciation, and an added factor to cover AEC overhead, interest on Government investment, process improvements, special handling, and other intangible expenses.

Charges for enriched uranium.—On November 18, 1956, supplementing the President's announcement of that date regarding the program for making uranium fuel available for power and research reactors abroad, the Commission announced its prices for enriched uranium. The newly announced price for uranium 235 at an enrichment of 20 percent is about $16 per gram as uranium hexafluoride. The new schedule supersedes the previous unclassified price of $25 per gram of uranium 235 as uranium metal of 20 percent enrichment for research reactor quantities.

The new schedule is based on provision of uranium as hexafluoride rather than as metal (the form contemplated in the 1955 schedule); and on transactions in larger quantities than those contemplated in the 1955 schedule which was limited to transfers of not more than 6 kilograms of uranium 235.

The Commission's prices as set forth in the schedule are not guaranteed, but, as in the case of its other prices, it is the intention of the Commission to maintain the price schedule on as stable a basis as is possible. As stated in last year's testimony, the Commission does not intend to make a change unless technological or other factors substantially increase or decrease costs.

The price schedule applies to the material in the form of uranium hexafluoride, withdrawn from the gaseous diffusion plants at Oak Ridge, Portsmouth, or Paducah. Conversion to other forms, such as uranium oxide or metal, will be performed for private users by the Commission only if commercial facilities are not available. In this case, the charges for such conversion services will be based upon the pricing policy outlined above which provides for recovery of AEC's full costs, or the use of the going commercial rate, if appropriate to avoid development of commercial sources of such services.

The schedule also applies to the credit given for residual material which is returned to the Commission after usage. In this case also the prices are applicable only to material in the form of uranium hexafluoride. The Commission hopes that industry will provide its own facilities for the recovery of scrap or irradiated material and reconversion to the form of uranium hexafluoride. Where this is not possible, appropriate charges will be made by the Commission to cover the costs of converting material accepted by it in other forms to uranium hexafluoride.

Guaranteed prices to be paid by AEC for special nuclear material.—Section 56 of the Atomic Energy Act authorizes the Commission to establish the fair prices to be paid for special nuclear material produced in licensed facilities and to guarantee such prices for a period not to exceed 7 years. The schedule of

guaranteed fair prices to be paid for special nuclear material produced in the 7-year period ending June 30, 1962, was established in January 1955 on a classified basis. These prices covered plutonium in metal form and uranium 233 in metal or nitrate salt form for both military and fuel uses. On November 18, 1956, the Commission announced the establishment of unclassified guaranteed fair prices for plutonium and uranium 233 for reactor fuel use for 1 additional year beginning July 1, 1962. These prices are $12 per gram for plutonium metal and $15 per gram for uranium 233 as nitrate salt, and are based on the estimated fuel value of plutonium and uranium 233 in relation to that of uranium 235 when research and development now in progress leads to methods for the use of these materials as reactor fuels. These prices for plutonium and uranium 233 will result in revenues for typical thermal reactors in the order of 1 mill per kilowatt-hour.

With respect to foreign purchases and as announced by the President on November 18, 1956, the Commission stands ready to buy, at specified prices, during the period ending June 30, 1963, all plutonium and uranium 233 offered to the United States which has been produced in reactors abroad, fueled with material furnished by the United States.

In keeping with the President's announcement that the material so acquired will be used solely for peaceful purposes, the prices specified are those indicated above, $12 per gram for plutonium and $15 per gram for uranium 233, which are based upon the estimated fuel values of these materials.

Under existing authority, such foreign purchases will be made upon an annual basis and subject to the availability of appropriations. The Commission expects to recommend at this session of the Congress legislation which will provide authority to the Commission, with the approval of the President, to establish guaranteed prices for purchase of plutonium and uranium 233 from reactors abroad, fueled with material supplied by the United States.

Other prices previously announced by the Commission of $40 per kilogram for natural uranium metal, $43 per kilogram of thorium metal, and $28 per pound for heavy water, remain unchanged as do the classified prices for depleted uranium. With respect to thorium metal, the current indications are that commercial source of supply will be developed in the near future, which should make it unnecessary for the Commission to continue to supply this material.

Indemnity against liability

There has been no significant change with respect to the problem of Government indemnity against liability arising from nuclear incidents since proposed legislation on this subject was considered by the Joint Committee during the last session of the Congress. The organizations engaged in the planning and construction of large power reactors have given no indication of changing their views with respect to the need for such indemnity. Those going ahead with construction are doing so on the assumption that it will be provided. The Commission believes, therefore, that enactment of such legislation is still essential if the present rate of development of nuclear power is to expand or even be continued.

The syndicates which have been organized by the insurance industry to provide property and liability insurance covering major nuclear energy risks are understood to be about ready to issue policies. (Premium rates to be given if available by time of hearings.) It appears, in most cases at least, that this coverage will be adequate except for public liability. The concern about the remote possibility of claims for injury and damage in excess of the relatively large coverage which the private insurance industry is providing makes Government indemnity necessary.

The Commission is developing a specific legislative recommendation which it believes will meet the requirements for such indemnity. In doing so, it has given careful consideration to the coverage being provided by the insurance industry, recognizing that adequate protection from liability generally would be provided concurrently by insurance and by Government indemnity. The Commission's recommendations will be submitted in due course.

In connection with its consideration of the indemnity problem, the Commission, as reported in a later section of this testimony, has undertaken a comprehensive survey of the possible extent of damage from a runaway reactor. A preliminary report based on this survey will be submitted to the Joint Committee as soon as it has been completed.

Development of standards and specifications for special nuclear materials and other special materials

For accurate measurement of quantities of special nuclear materials it is necessary that standardized materials of each type be available so that the results of various measurement methods can be evaluated against a uniform standard.

The most pressing standards problem relating to peaceful uses of atomic energy concerns uranium isotopic standards. Accordingly, the Commission last year formed a Committee for Uranium Isotopic Standards and asked it to address itself solely to that problem. This Committee's report outlined plans for preparation and issuance of provisional standards until certified standards can be developed. In accordance with the recommendations of the Committee, work has been undertaken on provisional standards by the National Bureau of Standards.

The longer term and more comprehensive need for standards of various kinds is now being studied and recommendations developed by the AEC staff for consideration by the Commission.

Specifications for materials handled by the AEC are in various degrees of firmness. Since specifications are a necessary part of lease, purchase, or sales contracts, the AEC is developing such specifications to the extent necessary in its role as a routine supplier and recipient of materials to and from commercial channels.

Specificatons for the materials, upon which AEC payments of guaranteed fair prices will be based, have been published on a classified basis and sent to all access-permit holders.

The AEC is also undertaking to standardize the specifications for uranium hexafluoride for purchases and sales. Tentative specifications have been worked out to give industrial groups a clearer picture of the tolerances which are to apply to uranium hexafluoride received from the AEC or returned to the AEC.

Upon receiving assurance that material necessary to atomic industrial development is unavailable commercially, the Commission may enter into an agreement to furnish that material. In case this occurs, the specifications for that particular order are developed. Materials for which this type of action has been taken include enriched and depleted uranium metal and compounds, other than UF_6, and normal uranium metal and compounds.

Patents

The increased activity of American industry in the field of atomic energy is reflected in some measure by the increased number of patent applications filed by private industry and reported to the AEC by the Commissioner of Patents under section 151d of the Atomic Energy Act of 1954. During the past year approximately 450 applications have been reported as against some 135 in 1955 and 50 in 1954. The major portion of the inventions and discoveries covered by these applications have fallen in the following fields: Use of irradiations and radiochemical processes, reactors and components associated therewith, general chemical processing, uranium ore processing and uranium chemistry, and radiation instrumentation including detectors and well-logging apparatus.

A number of the applications that have been filed by private industry have been placed under secrecy order in accordance with section 181 of title 35, United States Code. The issuance of a secrecy order on an application does not prevent prosecution, but defers the issuance of a patent until the secrecy order is rescinded. Moreover, the imposition of a secrecy order on a patent application does not prevent the applicant from utilizing the invention or discovery subject, of course, to appropriate security safeguards. Periodic review is made of such secret applications so as to assure the issuance of patents and dissemination of information consistent with the common defense and security. It is anticipated that a number of the patent applications presently subject to secrecy orders can be declassified shortly as one result of the Commission's recent adoption of a new declassification guide, which was reported earlier in this testimony.

In pursuance of the program to encourage industrial participation, the Commission has made a portfolio of some 1,100 patents available for licensing. These patents fall in the following fields: Uranium and transuranic chemistry; ore-treatment devices and processes; general chemical fields, including beryllium, boron, fluorine, fluorocarbons, zirconium, heavy water, etc.; reactors and reactor

techniques; radiation detecting and measuring systems; particle accelerators and electromagnetic separating equipment and processes; mechanical equipment, including manipulators, pumps, valves, etc.; testing and measuring devices and processes, such as flowmeters, calibration equipment, radiographic techniques, etc.

In September of 1956 a tripartite agreement was concluded among the Governments of the United States, the United Kingdom, and Canada under which the United States acquired all rights in the United States in inventions or discoveries owned by the British or Canadian Governments which were the subject of United States patents or patent applications as of November 15, 1955. The United Kingdom and Canada retain a nonexclusive license in such inventions and discoveries for governmental and mutual-defense purposes.

The agreement also gives American nationals and industry the right to licenses in Canada and Great Britain on the same terms and conditions as are accorded British and Canadian nationals by their own Governments. The patents acquired by the United States Government under this agreement will be made available for licensing on a nonexclusive, royalty-free basis the same as other patents owned by the Commission. This will assure freedom of action not only by the United States Government but by American industry in the United States as respects those inventions which were made during the period when atomic-energy operations were largely a Government monopoly. At the same time it will assure that American industry will not be discriminated against as to these patents in Canada and the United Kingdom. (A fuller discussion of the tripartite agreement appears in the 21st semiannual report, pp. 104–106.)

The power bilateral agreements for cooperation under section 123 with Canada, the United Kingdom, Austrialia, Belgium, the Netherlands, and Switzerland contain provisions under which the United States acquires rights in the United States in any invention made by persons under the jurisdiction of the foreign government that results from interchange of information classified when communicated, as well as include a provision as respects nondiscrimination against American nationals in the issuance of licenses in such foreign countries. The numerous research-reactor agreements providing for the interchange of unclassified information contain no patent provisions.

The Commission has pursued the practice of having contractors, when reporting inventions, indicate whether they desire to file any United States or foreign patent applications. If the invention does not involve classified subject matter, the Commission has promptly notified the contractor to proceed to file the United States and any foreign applicaions the contractor desires. In instances involving restricted data, foreign applications, of course, have only been filed by the contractor or the Commission where the subject matter involved falls within the scope of information exchangeable under an agreement for cooperation negotiated under section 123 of the Atomic Energy Act, after it has been ascertained that the subject matter is of sufficient importance to warrant the filing in the foreign country.

The Commission has not filed any directive to have a patent issued to the Commission under the provisions of section 152. The Commission has continued to employ contract provisions under which the Commission has the right to acquire all rights in inventions in the atomic-energy field.

Further, the Commission has not invoked compulsory licensing as authorized by section 153, nor has any compulsory licening proceeding been initiated by any private party.

To assist industry in development of peaceful uses of the atom, the Commission has issued regulations waiving its rights under section 152 as respects inventions resulting from access to restricted data and inventions made as a result of the use of materials or services sold or otherwise made publicly available. The Commission feels that these waivers will provide incentive to private persons to utilize such information, materials, and services to develop peacetime applications of nuclear energy. Furthermore, a General Counsel opinion has been issued that a license from the Commission is not a contract, arrangement, or other relationship as those terms are used in section 152. (This is more fully set forth in the 21st seminannual report, pp. 105–106.) These regulations and interpretations have clarified for industry the position of the Commission with respect to the exercise of its rights under section 152.

VIII. Progress in the Nuclear Reactor Field

As envisaged by the national policies established in the Atomic Energy Act of 1954, private industry is playing an increasingly important role in the nuclear reactor field. With opportunities expanded by the act, free and competitive American industry has moved on a broad front to develop atomic-energy enterprises.

STATUS OF REACTOR PHASE OF ATOMIC INDUSTRY

During 1956 the number of companies participating in the reactor phase of the atomic-energy industry and their gross volume of business gained markedly.

As of December 31 at least 21 companies were constructing or planning to construct civilian power or research reactors. It should be recognized that other companies which have not yet obtained reactor business are also offering their services. At least one manufacturer expects to have small portable research reactors "for sale off the shelf by March 1957."

Entrance of private enterprise into the reactor phase of the atomic-energy industry since the passage of the Atomic Energy Act of 1954 has been facilitated by several major governmental actions.

Procurement by the Commission under the expanding civilian and military reactor programs has opened new markets to private suppliers. Allocation by the President of enriched fuel for domestic and foreign reactors was an essential action. Sales of research reactors to foreign countries have been stimulated by United States Government grants and by Commission regulations enabling American firms to participate more widely in industrial activity abroad. AEC declassification and access permit policies have made much technical information available to potential private suppliers.

In the building of nuclear reactors for power or for research, diverse skills are required. New metals, vacuum welders, unusual valves and pumps, catalytic recombiners, intricate heat exchangers, specialized instrumentation, and a host of other components are supplied by companies which specialize in these fields but do not necessarily have extensive atomic-energy experience. Many of these companies have set up new divisions in order to expand their activities in the atomic industry.

In other instances cooperative groups have been formed to share research facilities or to promote atomic developments that might be too expensive for any single member company. For example, 24 companies, with diverse interests ranging from food processing to papermaking, have joined in support of the construction and operation of the $700,000 research reactor completed during 1956 at the Armour Research Foundation in Chicago. Power Reactor Development Co., Inc., Yankee Atomic Electric Co., Nuclear Power Group, and the recently formed Carolinas-Virginia Nuclear Power Associates, Inc., are examples of industrial groups formed for the cooperative development of nuclear powerplants in their geographical areas.

Engineering companies and reactor manufacturers are participating in various arrangements with the ultimate utility operators in the actual development work on the specific types of nuclear powerplants. Prominent among these industrial participants are the Babcock & Wilcox Co. (Consolidated Edison Co. reactor), General Electric Co. (Commonwealth Edison Co. reactor), Westinghouse Electric Corp. (Pennsylvania Power & Light Co. reactor), and Nuclear Development Corporation of America (Chugach Electric Association reactor).

COMMISSION PROGRESS IN POWER-REACTOR DEVELOPMENT

It might be well to repeat the overall Commission policy with respect to the development of nuclear reactors. The future atomic-energy industry must be built on a broad and solid technological base. The Commission, through the work of industrial and university research and development contractors, carries the major responsibility for developing the basic technology for all types of reactor systems.

The international situation demands that military efforts continue to be a major part of these basic developments. Military reactors, primarily those for propulsion purposes, still require more than three-fifths the effort and budget of the Commission's reactor-development program. In many ways these activities are of direct benefit to the peacetime developments, and more and more of the

data resulting from them which have no military bearing are being declassified and made available to the reactor industry. Also a portion of the basic technical information useful in civilian power-reactor design and operation, which is developed in our military reactor work, is being made available to the reactor industry through the access-permit program.

The Commission believes that American industry has the major responsibility for the practical applications of peacetime nuclear developments—for designing, building, and operating nuclear power reactors, process heat reactors, food irradiation reactors, or commercial reactors for other purposes. To become economic, nuclear power must meet more stringent requirements in the United States than in any other country because of our low-cost fossil fuels. The Commission believes that success will be achieved more surely and more quickly by pursuing simultaneously several technological approaches to practical power reactors. Several different types of power reactors will be needed to meet varying requirements of capacity, physical size, location, and available fuel resources. The Commission program of reactor development is designed to satisfy so far as possible these military and peacetime needs.

ACCOMPLISHMENTS IN REACTOR DEVELOPMENT

Following are some of the more important accomplishments of the combined activity of industry and Government, many of them occurring in the past year:

1. As reported in the latest tabulation "Nuclear reactors built, building, or planned in the United States" (which is appended for easy reference as table Ia and is also included in the 21st semiannual report (pp. 348–363)), this Nation had as of the end of 1956 built and operated 61 reactors of various types, excluding critical experiments and zero power reactors. To the best of our knowledge, this is considerably more than have been built and operated in all other nations of the world (chart I).
2. The number of power-reactor sales now under negotiation between American firms and foreign countries under the atoms-for-peace program is reaching significant proportions.
3. The number of research and test reactors built or building in the United States continues to increase (table Ia and charts I and II).
4. In the research reactor field, there is promise of rapid growth in reactors for medical research and therapy. The first reactor designed specifically for this use is under construction at Brookhaven National Laboratory. At the end of December it was 11 percent complete (21st semiannual report, p. 79).
5. The number of power reactors built or building in the United States continues to increase (table Ia and charts I and II).
6. Work has begun on the development of the first nuclear-powered merchant ship as a joint endeavor of the Commission and the Maritime Administration (21st semiannual report, p. 45).
7. Studies have been made on a number of possible applications of reactors for other purposes such as locomotives, overland cargo carriers, gasification of coal, process heating, and sources of radiation for chemical reactions and physical effects.
8. The supply of important reactor materials has been increased and their cost lowered through contracts with industrial suppliers (20th semiannual report, pp. 54–56 and 21st report, p. 47).
9. A program looking toward development of practical means for utilizing plutonium as fuel in power reactors has been initiated (20th semiannual report, p. 42; 21st report, pp. 43, 44).
10. Expansion of the Commission's activities has taken place in the fields of reactor safety, site selection, and waste disposal (20th semiannual report, pp. 59–62, 113–114; 21st report, pp. 48, 143–161).

INFUENCES SLOWING DEVELOPMENT

Following are some causes of difficulty and delay encountered recently in the pursuit of economic nuclear power:

1. Adequate public liability insurance coverage has not yet been provided.
2. Increased costs of nonnuclear power equipment have raised capital requirements for nuclear plants as well as for conventional plants.
3. The shortage of technical manpower makes staffing of projects difficult.
4. Because of the laws under which they operate and their own nature, public and cooperative power groups have found it necessary to impose ceilings on the

amount of construction and operating costs to be borne in their nuclear power developments.

5. High capital costs and high fuel fabrication costs continue to be major economic barriers.

6. Materials problems unrelated to nuclear design or operation have delayed experimental reactor projects.

It is significant nevertheless that, as 1957 opens, 5 full-scale civilian nuclear powerplants are in various stages of construction, and plans—in various stages of discussion or negotiation—have been announced for 11 other such plants.

GOVERNMENT ACTIONS AIDING DEVELOPMENT

Two governmental actions of 1956 have helped to speed atomic power development:

1. In February 1956, as noted earlier, the President announced that 40,000 kilograms of uranium 235 would be made available for peaceful purposes. Of this total, one-half is earmarked for domestic uses, principally for powerplants, and one-half is available to friendly foreign nations and to the new International Atomic Energy Agency when that organization begins operations.

In October 1956, a specific pledge of 5,000 kilograms (to be taken from the February allocation) was made to the Agency by a Presidential letter to the Conference on the Statute of the Agency. In addition to the 5,000 kilograms the Presidential letter pledged that the United States will match the total contribution of nuclear materials by all other nations through July 1, 1960.

2. In November 1956, the Commission announced unclassified prices which the Government thenceforth would charge for nuclear fuels both at home and abroad and the first unclassified prices which the Government would pay for plutonium and uranium 233 produced as a byproduct of foreign civilian nuclear powerplants, which obtain their fuel from the United States under an agreement for cooperation, and for these same materials produced by domestic power reactors. Assurances have been given that all plutonium purchased under our atoms-for-peace agreements will be used only for peaceful purposes.

STATUS IN 1957 OF MAJOR POWER REACTOR PROJECTS

The present status of the civilian power reactor programs of industry and the Commission has been described in detail in the 21st semiannual report. Hence, only a brief summary of these programs, of the manner in which they are planned and undertaken and of the present status of the indivdual projects is presented in this testimony.

Basic points of philosophy expressed to the committee by the Commission in April 1955 continue to guide Commission actions in this field. The two general principles are:

1. Developing economically competitive nuclear power for civilian use will be aided by maximum practical utilization of the financial incentive common to business ventures in order to stimulate ingenuity and imagination and the assumption of calculated technical and economic risks.

2. The Commission's role should be to develop advanced technology at Government expense and to stimulate outside groups to undertake developmental or demonstration power projects primarily with non-Commission financing.

In general the application of these principles has involved:

(*a*) Financing almost entirely by the Commission of experimental reactors and studies whose primary aim is to develop and prove out basic technology;

(*b*) Limited financial help by the Commission to industrial, cooperative, or public power groups in construction and operation of reactor demonstration projects which build on the technology developed in the experiments and add operational and economic data.

(*c*) Complete financing by industry of certain independent projects which also contribute further to technology and add operational and economic data.

Obviously, the Commission is influencing the technical approaches that will be tried in the search for economic nuclear power by its selection of the experimental projects to be undertaken to develop basic technology. Industry, cooperative, and public groups tend to base their full-scale projects on those experiments which have succeeded in advancing technology to the point where feasibility has been established. These full-scale projects tend further to develop the advanced technology and to press toward economic feasibility. Thus the Commission's decisions on basic experiments and its success or lack of success

in any particular experiment has essentially determined the directions in which current power reactor development is progressing.

In the President's message to the Congress on the budget for fiscal year 1958, the policy on financing of large-scale commercial power reactors was stated as follows:

"In the belief that basic responsibility for construction of large-scale commercial power reactors should not have to be assumed by the Federal Government, no funds for construction of new large-scale reactors are proposed in this budget. A number of new proposals from non-Federal interests are now being developed. However, if acceptable proposals for non-Federal construction of promising reactor types do not materialize within a reasonable time, a request will be made to the Congress for funds for direct construction by the Federal Government."

THE COMMISSION'S EXPERIMENTAL PROGRAM

The Commission's civilian power reactor program began with an experimental program for testing out five power reactor concepts. This was formalized in early 1954. Prior to that time, the production and military propulsion reactor programs, plus exploratory research and development work had developed a substantial amount of information on 80 or more reactor concepts.

The reactor projects finally proposed for experimentation represented the combined judgment of the staffs of AEC and principal contractors. Their recommendations were reviewed and endorsed by the Commission's General Advisory Committee. The recommendations were presented to the Commission for review and after consideration were approved. Next, the program was reported to the Joint Committee on Atomic Energy. The committee held hearing, receiving comment from leading nuclear specialists, and in February of 1954 endorsed the program. Through this process the best judgment of Government, business, and technical men was reflected in the planning of the program.

The five reactor concepts selected in 1954 were judged to be potentially capable of producing economically competitive nuclear power and to be sufficiently well advanced in technology to make construction of experimental reactors technologically feasible. The five original concepts were pressurized water, boiling water, sodium graphite, fast breeder, and aqueous homogeneous. The program is not static. It has expanded as new ideas generated. Today five more reactor concepts are being explored, namely, organic moderated, liquid-metal-fueled, gas cooled, molten plutonium, and heavy water natural uranium. The experimental program is also giving special attention to the development of technology for using plutonium as a reactor fuel.

Evaluations of proposals from whatever sources have required participation on the part of the Commission's staff, its National Laboratories, and industrial contractors. The process from time to time has involved specific evaluation assignments to the National Laboratories and industrial contractors and special meetings between key staff members of the Commission and its laboratory directors or other technical advisors.

All recommendations for starting new projects or making major changes in current projects are discussed with the General Advisory Committee. Either through the budgetary process or by direct project submission, each recommendation is taken by the General Manager to the Commission for its attention or approval.

The status of the experimental projects under way in early 1957—in various stages ranging from preliminary planning to on-line power generation—is as follows:

Pressurized water reactor (PWR)

As of January 31, 1957, overall construction was 67 percent complete on this 60,000-kilowatt nuclear powerplant at Shippingport, Pa. Criticality is expected late in 1957. Design of the second reactor core, which is expected to produce greater power than the first core, is proceeding at the Bettis plant of the Atomic Energy Commission.

Boiling water reactor experiment (BWRE)

Construction of this experimental reactor was completed and preliminary operations at full power (5,000 ekw) were conducted late in 1956 and early this year. When electric power from the machine is available, it will be used by the Argonne National Laboratory, the site of the reactor. The reactor's initial operations will be with light water but it is intended to fabricate a new core

loading for use with heavy water if initial operations with light water show this to be practical.

Boiling reactory experiments (BORAX)

The third in a series of boiling water reactor feasibility experiments, designated BORAX–3, conducted by the Argonne National Laboratory at the Idaho National Reactor Testing Station, completed 6 months of operation at design temperature and pressure and at power levels sufficient to allow generation of about 2,000 electrical kilowatts. This performance with aluminum clad uranium alloy fuel elements was substantially better than anticipated. Operation of the facility with a set of aluminum uranium oxide-thorium oxide-fuel elements (BORAX–4) was initiated late in 1956.

Argonne boiling reactor facility (ARBOR)

Current work in the boiling water reactor program will be supplemented by the construction and operation of this facility at the National Reactor Testing Station. By simulating experimentally a wide range of operating conditions pertinent to the performance of boiling water reactors, ARBOR is expected to contribute materially to the progress of design studies now underway on boiling water central station nuclear powerplants.

Sodium reactor experiment (SRE)

Installation of components in this reactor, being built by Atomics International, a division of North American Aviation, Inc., at Santa Susana, Calif., nears completion following some construction difficulties which led to delays. Criticality is expected in early 1957, followed by power operation during which up to 6,000 kilowatts of electricity will be fed into the lines of Southern California Edison Co.

The Commission feels that sodium technology still offers great promise for land-based central station nuclear powerplants despite the experience with superheater and steam generator leaks in the submarine *Searwolf's* sodium reactor plant.

Experimental Breeder Reactor No. 1 (EBR–1)

The core of this reactor, which was damaged during a series of transient experiments in November 1955 was removed from the reactor and shipped to the Argonne National Laboratory for detailed examination. Much has been learned from examination of this core. The EBR–1 had operated for nearly 4 years since the world's first nuclear electric power was produced by it in December 1951.

A replacement core of highly enriched uranium 235 is being manufactured in order to put the reactor back into operation late in 1957. This core will be designed to avoid the free bowing of the fuel elements which it is believed caused the nuclear instabilities observed in operation of the reactor with the second core. It is expected that the new core will demonstrate greatly improved stability.

Experimental Breeder Reactor No. 2 (EBR–2)

The conceptual design has been completed and architect-engineering work has begun on this 15,000 electrical kilowatt experimental reactor to be located at the National Reactor Testing Station in Idaho. Construction of the reactor is scheduled to start in July 1957. The plant is scheduled to begin operation during 1959. Meanwhile a large mechanical mockup of the core and associated equipment was operated successfully at the Argonne National Laboratory. Large scale hot sodium pumping tests were also started. Critical experiments were carried out at Idaho to establish the nuclear physics characteristics of the EBR–2 core.

Homogeneous reactor experiment No. 2 (HRE–2)

Startup of the reactor at Oak Ridge National Laboratory has been delayed by stress corrosion cracking in the leak detector system and possibly also in the connecting high pressure system. The reactor itself is not affected. The damage was discovered during nonnuclear test operation of the reactor system during December, 1956. The extent of the replacements necessary and the consequent delays will be determined after further test operation in January and February.

Although it had been hoped that a slurry blanket might be utilized with this reactor (instead of the heavy water reflector to be used initially), it does not now

appear feasible and plans are underway for a third experiment, HRE–3, utilizing a slurry of thorium oxide for the blanket.

Los Alamos power reactor experiments (LAPRE)

The Los Alamos power reactor experiment No. 1 (LAPRE–1) utilizing a compact, gold-clad reactor fuel with uranium 235 dissolved in concentrated phosphoric acid was started up twice during the year. On both occasions failure caused by corrosion occurred rapidly. It has been decided to abandon this experiment.

A second experiment, LAPRE–2, will benefit substantially from the experiment with LAPRE–1. It is similar to LAPRE–1 except that it depends on thermal convection rather than pumped circulation. LAPRE–2 was assembled for testing during the year.

Organic moderated reactor experiment (OMRE)

Design and construction was started during 1956 by Atomics International at the National Reactor Testing Station in Idaho of a reactor experiment to demonstrate the feasibility of utilizing organic materials such as diphenyls or terphenyls as coolant and moderator for a power reactor. Operation of the experiment, which will produce 5,000 to 16,000 thermal kilowatts (no electricity), is scheduled for mid-1957.

Liquid metal fuel reactor experiment (LMFRE)

Studies and development work on reactors utilizing as fuel a solution of uranium 235 or uranium 233 in molten bismuth have been conducted at the Brookhaven National Laboratory for a number of years. The use of a blanket of thorium and bismuth particles as a slurry in bismuth has been investigated. Plans and designs for a reactor experiment are now being developed by Brookhaven and by Babcock & Wilcox, selected as the contractor, but the details of the design and the location of the reactor have not yet been decided.

Gas-cooled reactor experiment (GCRE)

Contract negotiations with the Aerojet-General Corp. for design, fabrication, and initial operation of this reactor at the National Reactor Testing Station have been completed. Although this experiment is part of the Commission's Army reactors program and will provide data and experience to meet military needs, the concept has potentialities as well for small civilian powerplants.

Molten plutonium reactor experiments

Research and development on molten plutonium alloys and containing materials led to formulation of plans for a Los Alamos molten plutonium reactor experiment No. 1 (LAMPRE–1) which is to be a reactor containing molten plutonium alloy. The coolant is to be sodium. The reactor will produce about 1,000 thermal kilowatts at about 1100° F. and is scheduled to go into operation in 1958. No blanket will be used for this first experiment. If this experiment is successful, LAMPRE–2 will be developed on a larger scale. Should LAMPRE–2 proceed as planned, it will have a thermal output of about 10,000 kilowatts as compared to 1,000 kilowatts for LAMPRE–1.

Neither LAMPRE–1 nor –2 will produce electric power, but they will serve as engineering guides for designing a larger LAMPRE–3 which may produce about 15,000 kilowatts of electricity.

As part of this program, molten plutonium fuel samples utilizing tantalum as the containing material have been irradiated in the materials testing reactor with very favorable results.

Heavy water power reactor development work

The Commission has negotiated a contract with E. I. du Pont de Nemours & Co., Inc., for studies and evaluations of natural uranium fueled, heavy water moderated and cooled power reactors based on the Savannah River production reactors which the company operates for the Commission.

Plutonium recycle development work

The Commission has accepted a revised proposal from the General Electric Co. for a program to demonstrate the feasibility of recycling plutonium in power reactors. The use of plutonium as reactor fuel will be a major step forward in the program to achieve low-cost nuclear power both here and abroad.

Further details about projects in the experimental program are given in table Ib and in TID–4562, a brochure giving technical and pictorial data on some ex-

perimental and test reactors which has been distributed to members of the committee.

POWER DEMONSTRATION REACTOR PROGRAM

The Commission's power demonstration reactor program was inaugurated in January 1955, with a first invitation which has been suceeeded by two later ones. In this program, private, cooperative, and public power groups and the Commission are participating jointly to develop prototype power reactor plants to demonstrate technical and economic feasibility of various reactor concepts.

Proposals submitted to the Commission are evaluated by the Commission's staff with assistance as necessary from its National Laboratories and other technical advisers. Selected directors of National Laboratories served as members of a technical advisory group in considering proposals received as a result of the first invitation under this program. Subsequent technical evaluations have been made primarily by the Commission's staff with the aid of consultants. In addition to its technical evaluation, the Commission processes such proposals in a normal procedure for contractor selection with a Selection Board composed of key staff members representing the Divisions of Reactor Development, Finance, and Civilian Application. Board Chairmen thus far have been managers of AEC Operations Offices. Recommendations of the Board are made to the Director of Reactor Development. Final approval or rejection of a proposal as a basis for contract negotiations is given by the Commission.

The scheduling of demonstration reactors in relationship to the stage at which the technology stands is a matter of judgment. With larg risks, full-scale plants could be built without the benefit of reactor experiments. On the other hand, conservative engineering would require 6 months to a year of operating experience with an experimental plant before freezing design specifications on a full-scale unit. Since a variety of reactor experiments is being carried on, it seems appropriate that large-scale nuclear powerplants be built utilizing the results of these experiments which have proven successful in developing new technology. Thus far it has appeared possible to provide for continuation of promising lines of development through to large-scale plants on a timely schedule by working with private, cooperative, and public power groups.

First invitation

The first invitation under this program was issued in January 1955. It carried a deadline of April 1, 1955, and specified no particular sizes for the reactor plants.

The first-round proposals as finally accepted for contract negotiations were:

Company and location of reactor	Type	Builder	Electrical generating capacity (kilowatts)
Yankee Atomic Electric Co., Rowe, Mass.	Pressurized water	Westinghouse Electric Corp.	134,000
Consumers Public Power District of Columbus, Nebr., Beatrice, Nebr.	Sodium graphite	North American Aviation, Inc.	75,000
Power Reactor Development Co., Inc. (Detroit Edison and others), Monroe, Mich.	Fast breeder	Power Reactor Development Co.	100,000

The status of each is as follows:

Yankee.—A contract between the Commission and Yankee was signed in June 1956. Commission, Yankee, and Westinghouse representatives are meeting quarterly to go over the progress which has been made and to review the long-range plans for completing this plant.

Consumers.—Contract negotiations are in progress.

Power Reactor Development Co.—A contract between the Commission and the company is under negotiation. The excavation for the reactor has been completed and the first three layers of concrete for the foundation have been poured. A railroad leading into the site has been built, and work is beginning on construction of the buildings and foundation for the power machinery. Considerable high-temperature testing of heat exchangers containing liquid-metal coolant has been carried out.

Second invitation

In September 1955 a second invitation was issued specifying generating capacities of 5,000 to 40,000 kilowatts. By the deadline of February 1, 1956, seven proposals were received, as follows:

Organization	Type	Builder	Electrical generating capacity (kilowatts)
Chugach Electric Association, Inc., Anchorage, Alaska, jointly with Nuclear Development Corporation of America, White Plains, N. Y.	Liquid sodium-cooled, heavy-water, moderated.	Nuclear Development Corporation of America.	10,000
City of Piqua, Ohio	Organic-moderated	North American Aviation, Inc.	12,500
Rural Cooperative Power Association, Elk River, Minn.	Closed cycle, boiling water.	AMF Atomics, Inc	22,000
Wolvering Electric Cooperative, Big Rapids, Mich.	Agueous, homogeneous.	Foster-Wheeler Corp.	10,000
City of Holyoke Gas and Electric Department, Holyoke, Mass.	Gas-cooled (nitrogen) gas turbine.	Ford Instrument Co.	15,000
Orlando Utilities Commission, Orlando, Fla.	Liquid metal fuel		25,000–40,000
University of Florida, Gainesville, Fla.	Pressurized light water.	Alco Products, Inc.	500

The Commission has authorized contract negotiations with the first four organizations. These are proceeding. The remaining three proposals were rejected on January 2, 1957, for the following reasons:

Cities of Orlando and Holyoke.—These proposals were considered to be technically premature.

University of Florida.—The proposed reactor was primarily for research and training purposes and had little value for developing economic commercial nuclear power. The Commission has other programs of assistance in research and training activities of universities.

Further details about the accepted proposals in the first two rounds of the power demonstration reactor program are given in table Ib.

Third invitation

The Commission has expanded the power demonstration reactor program by extending a third invitation (as of January 7, 1957) for proposals to develop, design, construct, and operate nuclear powerplants. No limitation has been placed on the types or sizes of plants which may be proposed except that they should make significant contributions toward the achievement of commercial utilization of nuclear power and that construction will be completed by June 30, 1962.

The assistance to be provided is of three general types: (1) Waiver of established Commission charges for use of source and special nuclear materials over a specified period of time; (2) performance either without cost or at less than full cost in Commission laboratories of mutually agreed-upon research and development not reasonably available elsewhere; and (3) support of research and development required to advance the technology of projects which promise to make a significant contribution toward achieving cheap, abundant, and safe nuclear power.

Reactor projects which might qualify for such assistance under the third invitation will probably take one or more of the following forms:

1. Duplicates of nuclear powerplants already built or under construction. Such plants would advance the overall development of the American atomic industry and for that reason would qualify for the waiver of use charges. An example might be another Yankee-type pressurized water reactor powerplant utilizing the same fuel elements.

2. Reactor systems which would represent significant technical or economic improvements over power demonstration projects now included in the Commission's program. In addition to the waiver of use charges the amount of research and development support to be provided would depend upon the anticipated overall contribution to power reactor development. The research and development support would be for worthwhile work actually to be performed. Due account would be taken of the related work already done or underway. Examples might be pressurized water or boiling water reactors with improved type fuel elements or with significantly simplified control systems.

3. The development and construction of demonstration nuclear powerplants of promising new types for which no prototype project has been started but which represent the application of relatively well-developed technology. In addition to the waiver of use charges, substantial support of research and

development might be required. Examples are: Natural uranium fueled, heavy water-moderated reactors and fluid-fuel reactors based on aqueous solutions or slurries of uranium or of uranium and thorium-bearing materials.

4. The development and construction of demonstration nuclear powerplants based on other reactor types which may or may not be under current development or study. In such cases the decision as to whether or not such work would qualify under the third round would depend to a considerable extent on the ability to make firm, realistic plans for completion of the nuclear powerplant before June 30, 1962.

If successful design and construction of the reactor contemplated require completely new basic development work, it may well be more appropriate to propose a contract with the Commission for such work rather than making a proposal under the third invitation of the demonstration reactor program.

The foregoing gives a general outline of the ground rules for this new invitation. The Commission will be pleased to consider any practical proposals which would advance the time when nuclear power will become economically competitive.

INDEPENDENT INDUSTRIAL PROJECTS

Eight industrial or utility organizations in early 1957 are building or propose to build nuclear powerplants without Federal Government financial participation. The organizations and reactors involved are the following:

Organization and location	Type	Builder	Electrical generating capacity (kilowatts)
Consolidated Edison Company of New York (Indian Point, N. Y.)	Pressurized water	Babcock & Wilcox	250,000.[1]
Commonwealth Edison Co. (Dresden, Ill.)	Boiling water	General Electric	180,000.
General Electric Co. and Pacific Gas & Electric Co. (Livermore, Calif.)	do	do	3,000.
Pennsylvania Power & Light Co. (eastern Pennsylvania).	Aqueous Homogeneous.	Westinghouse	150,000.
Florida Power Corp., Florida Power & Light Co., and Tampa Electric Co. (Florida).			Up to 200,000.
New England Electric System (New England).			200,000 or more.
Carolinas-Virginia Nuclear Power Associates, Inc.[2]			10,000–30,000.
Middle South Utilities, Inc.			20,000.

[1] 140,000 kilowatt nuclear; 110,000 kilowatt oil fired.
[2] Virginia Electric & Power Co., Carolina Power & Light Co., Duke Power Co., and South Carolina Electric & Gas Co.

The Commonwealth Edison Co. and Consolidated Edison Co. projects were granted construction permits by the Commission in May 1956. Major equipment orders have been placed. Major construction on both jobs is expected to start in 1957, and operation to begin in 1960.

The General Electric Co.-Pacific Gas and Electric Co. project is under construction and completion is expected in 1957.

Research and development work preliminary to initiation of construction is well advanced on the Pennsylvania Power & Light Co. project. A complete report on progress, program plans, and problems was presented to Commission representatives at a meeting in October.

The last four organizations listed have not yet developed detailed plans.

The overall civilian power reactor program includes in its three phases projects involving many different contractual and financial arrangements—complete Government financing, complete industry financing, and joint participation. In many cases projects have been delayed because of the time required for new technical developments, the fabrication of complex and unusual components and the replacement of materials under the conditions of operation required in nuclear power plants.

However, in all cases, once construction has been committed there are strong incentives to complete the projects as expeditiously as possible.

REACTORS FOR OTHER INDUSTRIAL USES

Process heat

Nuclear fission offers a potentially useful source of process heat with distinct advantages as to temperature ranges, methods of application, and geographic flexibility of plant locations.

Some examples of industrial processes which might take advantage of nuclear process heat include coal gasification, nitrogen fixation, acetylene production, and hydrocyanic acid production. Other applications are likely to develop. Tests under simulated conditions to explore feasibility of the application of nuclear heat to coal gasification are now going forward at the Bureau of Mines' Appalachian Experiment Station in Morgantown, W. Va. Experiments in nuclear process heat systems may indicate the desirability of building a high temperature test reactor and carrying out a number of supplemental projects to develop components. In addition, furnace testing of irradiated sample ceramic fuel elements to establish their stability and fission product retention at temperatures up to 3,000° F. has already been started.

Contracts may be let soon for the development of a 1,000° F. helium compressor for further experimental testing of equipment and components. In addition, several universities are also being considered for experimental work on measurement of various properties of ceramics and gases under temperatures up to 3,000° F.

In addition to the above work on high temperature process heat, there are industrial studies contemplating the use of reactor produced steam for space heating and process use. Conceptual designs of such nuclear heating plants indicate that reactors for this purpose can be considerably lighter and less costly than power reactors because steam quality need not be so high where no turbine generator is involved.

Commercial ship propulsion

Application of nuclear power to merchant ships is one of the economically promising applicatitons of nuclear energy. As compared with conventionally powered ships, it is expected that reactor-powered ships will be able to carry larger cargoes, operate on longer runs at higher sustained speeds, achieve quicker turnaround in port, and be more flexible in the routes they can travel.

Pursuant to Public Law 848 passed by Congress on July 23, 1956, and the subsequent direction of the President on October 15, 1956, the Maritime Administration, Department of Commerce, and the Commission are going forward on the development of the first nuclear-powered merchant ship. This first ship is not expected to be economically competitive. Detailed design and system analyses on the propulsion plant have been initiated by the Babcock & Wilcox Co. Under a proposed contract now being negotiated the company will design and construct a 20,000 shaft horsepower pressurized water reactor system of advanced design. Contracts have been let to the Gibbs & Cox Co. for the marine architectural engineering aspects of the ship design. Surveys of qualified shipyards have been made preliminary to selection of a yard to build the ship.

Looking forward to subsequent nuclear powered commercial ships, studies are being made to determine the nuclear propulsion systems and ship designs which offer greatest technical and economic promise.

Programs have been initiated to provide for the training of crews, for safe operation of nuclear ships, and for the establishment of international operating codes and practices. The Government's activity in the field of nuclear powered merchant ships is a joint endeavor of the Atomic Energy Commission and the Maritime Administration.

Food irradiation

The Commission has undertaken to provide sources of gamma radiation to assist in Army Quartermaster Corps experiments with irradiation as a process for preserving foods and improving qualities of rubber, plastics, textiles, petroleum products, and other materials.

The Commission is negotiating with Kaiser Engineers (division of Henry J. Kaiser Co.), Oakland, Calif., a contract for the research and development needed (1) to prove the feasibility of the food irradiation reactor preliminary design prepared in 1956 by the Internuclear Co., and (2) to refine the existing preliminary design, as necessary, to permit construction or else to prepare a new preliminary design. The reactor which is contemplated at present is water-moderated and water-cooled, with an MTR-type core surrounded by a blanket of neutron-activated isotopic material in an aqueous solution. Simultaneously, the Com-

mission is investigating the possibility of obtaining suitable cobalt 60 for use as a source of gamma radiation. If enough cobalt 60 of the requisite type can be secured at a suitable cost, it may prove desirable to abandon the reactor in favor of a cobalt facility.

Nuclear-powered locomotive

Nuclear-powered locomotives offer possible advantages of extended operation without refueling. Among the obstacles are cost and safety considerations and limitations on the size of railroad equipment. Baldwin-Lima-Hamilton Corp. and the Denver & Rio Grande Western Railroad, having studied nuclear locomotive possibilities together under the Commission's industrial participation program, are now supporting further study of the subject by Walter Kidde Nuclear Laboratories, Inc.

Army overland cargo carrier

The Commission's Army Reactors Branch has contracted with General Motors to perform a design analysis of a nuclear-powered logistical cargo carrier to fill Army Transportation Corps needs for a vehicle able to transport large tonnages of supplies in remote areas without depending upon long petroleum supply lines.

Isotope production

The importance of radioisotopes to industry, medicine, agriculture, and scientific research is dealt with elsewhere in this testimony (sec. II).

Isotopes continue to be produced as byproducts in the operation of various research reactors. The number of reactors which do or can produce isotopes is on the rise.

During the years 1946–51, Oak Ridge National Laboratory made all but a very few of isotope shipments. ORNL still remains the primary source of supply, but, in addition, there now is production by reactors at other AEC laboratories. Private reactors are now also beginning to produce isotopes.

Using radiation for industrial effects

Many studies are being conducted by industrial companies on the use of reactor radiations to produce various chemical reactions or physical effects. Some practical commercial use of radiation is now being made in producing temperature resistant polyethylene, but reactor produced radiation has not so far been so utilized.

Test reactors

It is becoming increasingly evident that test reactors are essential in order not only to determine the characteristics of specific reactor materials at high temperatures and in intense radiation fields but also to measure the mutual compatibility of such materials under conditions which closely simulate those to be found in the operating reactor. As a result, the need for test reactor capacity is increasing rapidly.

The Commission has stated that it will permit the use of Commission-owned test reactors for non-Government purposes only if private-owned facilities are not available for the irradiation services required. The Commission is actively encouraging industrial concerns to build these reactors as an essential part of their privately financed nuclear facilities, and has agreed not to construct such test reactors provided its needs for irradiation space can be met by these industry-financed facilities.

A number of companies and industrial groups have expressed considerable interest in building such facilities provided the financing can be worked out. Two privately financed general test reactors, one to be owned by Westinghouse Electric Corp. and the other by the National Advisory Committee for Aeronautics, are now planned.

Research reactors

Research reactors contribute significantly to power reactor development in two main ways:

1. They provide indispensable facilities for the training of reactor personnel.
2. Much of the work done in research reactors adds to the stockpile of basic information necessary for progress in reactor technology.

Research reactors are also used increasingly as direct tools in physical and scientific research, in medicine, agriculture, and industry. The Battelle Memorial Institute, for example, has indicated that its new research reactor at West Jefferson, Ohio, will be used in research for the chemicals, petroleum, metals,

machinery, ceramics, electronics, food processing, textiles, and pharmaceuticals industries.

During 1956, the following research reactors commenced operation or were licensed to operate in the United States:

Owner and location:
Atomic Energy Commission; Omega West Reactor, Los Alamos, N. Mex.
Naval Research Laboratory, Washington, D. C.
Armour Research Laboratory, Chicago, Ill.
Battelle Memorial Institute, West Jefferson, Ohio
University of Michigan, Ann Arbor, Mich.
Aerojet General Corp., San Ramon, Calif.

Chart III shows the geographical distribution of Government-owned and privately owned research reactors operating and building in the United States.

RELATION OF MILITARY AND CIVILIAN POWER REACTOR DEVELOPMENT

The contributions to the technology and development of civilian power reactors made by the Commission's reactor development work for the Army, the Navy, and the Air Force were given in some detail in the 1956 hearings. The chart presented at that time has been brought up to date and is shown herewith as chart IV.

DEVELOPMENT OF THE TECHNOLOGY OF SAFETY IN REACTOR DESIGN AND OPERATION

Safe operation of reactors

An important part of the development of reactor technology is directed toward solving the problems of reactor safety. The increasing stress that the Commission is placing on this phase of reactor development is shown by the fact that in 2 years the direct expenditures for this work have increased from $336,000 to more than $6 million per year.

The principal objective of the entire biomedical program is to assess the effects of radiation—both harmful and beneficial—on humans. In fiscal year 1956 approximately $17 million was expended for research pertaining to the harmful effects of radiation and to problems encountered in atomic energy operations involving radioactive and toxic materials. This research has been increased in fiscal year 1957 to approximately $18,500,000. Since the work is predominantly unclassified, its results as they may apply to reactor safety are readily available.

Even this total of nearly $20 million per year does not completely encompass the work being done in this area since a considerable part of the industrial effort involved in designing specific reactors also is directed toward this end.

Reactors such as SPERT and KEWB make possible integral experiments on reactor operation, particularly studies of transient behavior, which is not predictable from theory alone.

Findings from research in the reactor safety field have been summarized in detail in the 20th and 21st semiannual reports to the Congress. These summaries of results will be found in the 20th report, pages 61 to 62, and the 21st report, pages 132 to 150.

Waste disposal

One of the important unknowns in the calculation of the economics of power production from nuclear fuels is the eventual cost of disposing of waste products. The Commission has steadily increased its research into the basic science involved and the engineering problems to be solved before full-scale methods or equipment can become economical. The results during the past year of research, both in waste disposal specifically and in the separation of waste products, an important part of the whole complex, are reported in the 20th semiannual report, pages 59–62, and 113, 114, and the 21st semiannual report, pages 151 to 161.

In brief, it may be pointed out, work in this area has continued in two related but separable categories: (1) the quantitative assessment of the ability of the environment to receive safely low levels of radioactivity, and (2) the problems of handling and ultimate disposal of high-level radioactive wastes associated primarily with the chemical processing of irradiated fuels.

A full year's successful operation at KAPL, in which low-level wastes have been discharged to the Mohawk River, has demonstrated more definitively than

any prior experience the practicality, safety, and economy of such operations. To extend this application to ther areas and to anticipate similar problems at locations as yet not identified, supporting development activities have continued at Harvard University. In cooperation with the Massachusetts State Department of Health, Harvard is investigating the underlying hydrological, biological, and chemical phenomena involved in dilution of radioactivity in surface waterways. The work involves the use of various radio-tracers such as rubidium, scandium, and strontium. Work on a prototype scale was also initiated by Northwestern University on the Chicago Drainage Canal.

Activities related to the disposal of gaseous and solid wastes were carried out by the United States Weather Bureau, United States Geological Survey, the Johns Hopkins University, Harvard University, University of Illinois, and others. Although there remain specific problems such as high efficiency air cleaning at high temperatures and establishment of a facility to handle solid wastes in the Northwestern United States, it is apparent that the general problems disposal of low-level wastes can be solved by existing practical engineering means.

Two general investigative approaches have been used in dealing with the problem of high-level waste disposal. The first has been to develop methods for fixing or immobilizing the radioactive materials in some stable, inert material that would be unaffected by natural leaching or dissolution over long periods of time. These inert but radioactively "hot" materials could then be placed safely in carefully selected locations in the environment. Work along these lines has progressed at Brookhaven National Laboratory. There a laboratory-scale plant is converting fission product wastes to an oxide form followed by leaching and fixing of radioactivity in the leachate on montmorillonite clay. Preliminary engineering of a prototype plant was assigned to the Blaw-Knox Company of Pittsburgh, Pa.

At the Oak Ridge National Laboratory work was done on the fixing of radioactivity in mixtures of natural earth materials (limestone, shale, and sodium carbontae). The use of radioactive decay heat in accomplishing this fixation also has been under investigation. Other fixation studies are being carried out at Los Alamos with wastes peculiar to that installation. Conversion to oxide schemes are being investigated at Argonne National Laboratory and at the National Reactor Testing Stations' chemical processing plant.

The second approach has been to investigate the feasibility of direct disposal of high-level waste to the environment at specific locations and under carefully controlled conditions. At the Oak Ridge National Laboratory the use of surface pits excavated in the Conesauga shale formation as disposal facilities for certain intermediate level wastes was investigated.

The problems of disposal of high-activity wastes to the oceans and certain geologic formations have been considered in a number of discussions. Under contract with the Commission the Earth Sciences Division of the National Research Council considered the possibilities of underground disposal. In a preliminary way it has been indicated that direct disposal may be technically feasible in deep basin formations containing stagnant brines, in spaces dissolved in salt beds or salt domes, in excavations in impermeable shales and, under certain special conditions, perhaps in the unsaturated zones at considerable distances above the water table. Much development work would be required before such disposal systems could be put on a practical continuously operating basis. Laboratory work on the salt-dome possibility has been started at the University of Texas. Although general possibilities have been cited for sea disposal, numerous complex technical oceanographic questions have to be answered before the feasibility of such systems can be assessed in any quantitative way. Transportation problems and questions of international administration indicate that practical application of ocean-disposal systems for high-level wastes is a longer range consideration.

Because of the radiotoxicity and long half life of cesium 137 and strontium 90, removal of these from wastes would substantially simplify the disposal of the remainder. This approach is being tried at Hanford on certain types of wastes. However, at the present time separation efficiencies obtained are not sufficient to justify application of this method at other locations. Shipments of chemical processing wastes from the Idaho Chemical Processing Plant to Oak Ridge were initiated as a source of cesium 137. Here, however, recovery for radiation-source value rather than for waste-disposal purposes is the objective—removal efficiencies are not high enough for the latter.

Future proposed development activities in the fields noted above include—

1. Continued quantitative assessment of the environment for waste-receiving capacity.
2. High-efficiency, high-temperature air-cleaning equipment.
3. Systems for fixation of radioactivity in stable, inert carriers.
4. Laboratory and field investigation of direct high activity waste-disposal techniques in specific geologic formations.
5. Limited studies of present sea disposal operations.
6. Systems for removal of specific radioactive elements from waste streams.

Technical cooperation with other Federal, State, and interstate agencies in matters relating to environmental control will be continued.

DEVELOPMENT OF CONTROLLED THERMONUCLEAR REACTIONS FOR POWER

Looking to the longer future, power eventually may be developed from the fusion reaction by the isotopes of hydrogen. This is generally referred to as the controlled thermonuclear reaction. The Commission is rapidly accelerating the research program in this field, the Sherwood project.

As the Commission has repeatedly stated, all of this work is still in the basic research stage. Many years of intensive work probably will be required to develop a prototype thermonuclear device which might yield more energy than it consumes. After that, many more years will probably pass before a full-scale device could be developed that would be economically conmpetitive with other sources of power.

The United Kingdom is carrying on experimental programs of high quality in the controlled thermonuclear field. As evidenced by the report by the Soviet scientist, I. V. Kurchatov, the same appears to be true in the U. S. S. R. There is also evidence of relatively small experimental efforts in Germany, France, and Sweden. Japan and India are known to have given consideration to the problem, but we have no knowledge at this time of any experimental work in these two nations.

An exchange of classified and unclassified information in the field of the controlled thermonuclear research has been arranged with the United Kingdom under the provisions of the Agreement for Cooperation between the two nations. Several exchanges have already taken place. In October three British scientists from the team working on this problem visited the United States laboratories where the work is being carried on. Also in October, two Commission executives visited in England with the British managers of the research. In November 13 men from the United States research groups engaged in a 4-day conference at Harwell with the leading research men in the British project. Other exchanges of documents are continuing and consultations will be held periodically.

In order to give industrial firms entering upon the development of nuclear power from the fission reaction an opportunity to assess the likelihood of competition from the fusion reaction, the Commission on February 4, 1956, authorized the issuance of access permits for controlled thermonuclear information, and later amended the authorization to specify the precise conditions for access.

TABLE IA

NUCLEARS REACTORS BUILT, BUILDING, OR PLANNED IN THE UNITED STATES AS OF DECEMBER 31, 1956

The following tabulation includes as reactors all facilities built, building, or planned in the United States as of December 31, 1956, which are capable of sustaining a nuclear chain reaction, with the exception of experiments being conducted at weapons laboratories. Certain experiments relating to military propulsion systems are included in the statistical summary but are not listed in the tabulation because of their classified nature.

In the case of an experimental facility in which many reactor core designs may be tested during the life of the facility only one entry is made.

Startup dates shown for 1957 or later are estimates based on the best available information. The dates for non-AEC projects are the estimates announced by the sponsoring organizations.

Reactors are listed as being built under the following circumstances:

1. *Federal Government reactors.*—When ground is broken, components ordered, or contract awarded, whichever is first.

2. *Non-Federal Government reactors in the United States.*—When construction permit is issued by the Commission.

3. *Reactors for foreign locations.*—When an export license is issued.

Reactors are listed in the planned category under the following circumstances:

1. *Federal Government reactors.*—When publicly announced or when development work is started.

2. *Non-Federal Government reactors in the United States.*—When license application is filed with the Commission or public announcement is made, whichever is first.

3. *Reactors for foreign locations.*—When public announcement of project is made.

Listings in the builder column refer to the prime contractor in the case of Federal Government reactors and to the principal manufacturer in other cases. Builders' names, abbreviated in the column listing, are given in full on page 2.

ABBREVIATIONS FOR BUILDERS' NAMES

ACF	ACF Industries, Inc.
AGC	Aerojet-General Corp.
AGN	Aerojet-General Nucleonics, Division of Aerojet-General Corp.
ALCO	Alco Products, Inc.
AMF	AMF Atomics, Inc., a subsidiary of American Machine & Foundry Co.
ANL	Argonne National Laboratory, operated by the University of Chicago.
B. and W.	Babcock & Wilcox Co., The.
BAC	Bendix Aviation Corp.
CE	Combustion Engineering, Inc.
Convair	Consolidated Vultee Aircraft Corp.
Daystrom	Daystrom, Inc.
Dupont	E. I. duPont de Nemours & Co.
Fluor	Fluor Corp., Ltd., The.
F-W	Foster Wheeler Corp.
GDC	General atomic division of General Dynamics Corp.
GE	General Electric Co.
HKF	H. K. Ferguson Co., The.
KE	Kaiser Engineers, division of Henry J. Kaiser Co.
LASL	Los Alamos Scientific Laboratory, operated by University of California.
Lockheed	Lockheed Aircraft Corp.
Martin	Glenn L. Martin Co., The.
Met. Lab.	Metallurgical Laboratory of Manhattan Engineer District.
NAA	Atomics International, a division of North American Aviation, Inc.
NACA	National Advisory Committee for Aeronautics.
NRL	Naval Research Laboratory.
NDA	Nuclear Development Corporation of America.
ORNL	Oak Ridge National Laboratory, operated by Union Carbide Nuclear Co.
PRDC	Power Reactor Development Co.
PPC	Phillips Petroleum Co.
P. and W.	Pratt & Whitney Aircraft division, United Aircraft Corp.
West	Westinghouse Electric Corp.

	Operated, later dismantled	Operated or licensed to operate	Being built	Planned	Total
A. LOW TEMPERATURE (NOT USEFUL FOR POWER GENERATION)					
1. Research and test reactors, wholly or primarily for:					
(a) Research, United States locations	6	14	5	20	45
(b) Research, foreign locations		1	1	14	16
(c) Personnel training			1		1
(d) General testing, United States locations		1	1	2	4
(e) General testing, foreign locations				1	1
(f) Specialized testing		12	4	3	19
2. Critical experiments and zero power reactors:					
(a) United States locations, unclassified	5	17	6	6	34
(b) Foreign locations				1	1
(c) United States locations, classified (not listed)		7	4		11
3. Production reactors		13			13
Total, low temperature	11	65	22	47	145
B. HIGH TEMPERATURE POWER-PRODUCING REACTORS					
4. Military prototypes and experiments:					
(a) Unclassified	1	3	7	2	13
(b) Classified (not listed)				4	4
5. Full-scale military power reactors		2	8	17	27
6. Civilian power reactor experiments	5	4	4	5	18
7. Full-scale civilian power reactors:					
(a) AEC power demonstration reactor program			1	6	7
(b) United States locations, other than PDRP			4	6	10
(c) Foreign locations				7	7
Total, high temperature	6	9	24	47	86
Grand total	17	74	46	94	231

A. Low temperature (not useful for power generation)
1. RESEARCH AND TEST REACTORS

A. Low temperature (not useful for power generation)

1. RESEARCH AND TEST REACTORS

(a) Wholly or Primarily for Research, United States Locations

Name and/or owner	Designation	Location	Builder	Type	Startup	Dismantled
Operated, later dismantled:						
Chicago pile 1 (AEC)	CP-1	Chicago, Ill	Met. Lab	Graphite	1942	1943
Chicago pile 2 (AEC)	CP-2	Argonne Laboratory	Met. Lab	do	1943	1954
Argonne CP-3 (rebuilt as CP-3′) (AEC)	CP-3	do	Met. Lab	Heavy eater	1944	1950
Argonne CP-3′ (AEC)	CP-3′	do	ANL	do	1950	1955
Low power water boiler (AEC)	LOPO	Los Alamos	LASL	Homogeneous	1944	1944
High power water boiler (AEC)	HYPO	do	LASL	do	1944	1950
Operated or licensed to operate:						
Oak Ridge X-10 area reactor (AEC)	X-10-100	Oak Ridge	ORNL	Graphite	1943	
Brookhaven research reactor (AEC)		Brookhaven Laboratory	HKF	do	1950	
Low intensity test reactor (AEC)	LITR	Oak Ridge	ORNL	Tank	1950	
Super power water boiler (AEC)	SUPO	Los Alamos	LASL	Homogeneous	1951	
North American aviation water boiler neutron source (AEC)	WBNS	Van Nuys, Calif	NAA	do	1952	
Livermore water boiler (AEC)	LIWB	Livermore, Calif	NAA	do	1953	
North Carolina State College (Raleigh research reactor)		Raleigh, N. C		do	1953	
Argonne research reactor (AEC)	CP-5	Argonne Laboratory	ANL	Heavy water	1954	
Pennsylvania State University		University Park, Pa		Pool	1955	
Aerojet-General Corp.[1]	AGN-201	San Ramon, Calif	AGC	Homogeneous solid	1956	
Armour Research Foundation		Chicago, Ill	NAA	Homogeneous	1956	
Battelle Memorial Institute		West Jefferson, Ohio	AMF	Pool	1956	
Naval Research Laboratory		Washington, D. C	NRL	do	1956	
Omega West reactor (AEC)	OWR	Los Alamos	LASL	Tank	1956	
Being built:						
Livermore pool type reactor (AEC)	LPTR	Livermore, Calif	F-W	Pool	1957	
Oak Ridge research reactor (AEC)	ORR	Oak Ridge	ORNL	Tank	1957	
Brookhaven medical reactor (AEC)		Brookhaven Laboratory	Daystrom	do	1957	
University of Michigan		Ann Arbor, Mich	B. and W	Pool	1957	
Massachusetts Institute of Technology	MITR	Cambridge, Mass	ACF	Heavy water	1957	
Planned:						
Aerojet-general nucleonics [2] (8 reactors)		San Ramon, Calif	AGN	Homogeneous solid	1957	
Curtiss-Wright Corp.[2]		Quehanna, Pa	Daystrom	Pool	1957	
Dow Chemical Co.[2]		Midland, Mich		Liquid metal		
Industrial Research Laboratories, Inc.[2]		Plainsboro, N. J	AMF	Pool	1957	
The Prosperity Co.[2]		Coral Gables, Fla		do		
University of California (medical reactor)[2]		Los Angeles, Calif	NAA	Homogeneous		
State College of Washington [2]		Pullman, Wash	GE	Pool		
Daystrom Nuclear Division of Daystrom, Inc.[2]		Near Princeton, N. J	Daystrom	Graphite-water	1957	
Stanford Research Institute [2]		Palo Alto, Calif				
University of Buffalo [2]		Buffalo, N. Y	AMF	Pool		
University of Washington [2]		Seattle, Wash				
Watertown Arsenal [2]		Watertown, Mass	BAC	Pool	1958	
University of Virginia [2]		Charlottesville, Va		do		

Footnotes at end of table, p. 130.

A. *Low temperature (not useful for power generation)*—Continued

(B) Wholly or Primarily for Research, Foreign Locations

Name and/or owner	Designation	Location	Builder	Type	Startup	Dismantled
Operated: Switzerland [4]		Wurelingen	ORNL	Pool	1955	
Being built: Japan		Tokai-mura	NAA	Homogeneous	1957	
Planned:						
Brazil [5]		Sao Paulo	B. & W	Pool	1957	
Netherlands [5]		Amsterdam International Exhibit.	AMF	do	1957	
Federal Republic of Germany [5]		Munich	AMF	do	1957	
Argentine		Buenos Aires	GE	do		
Asian Nuclear Center						
Denmark [3]		Roskilde	F-W	Pool		
Italy [3]		Near Milan	ACF	Heavy water	1958	
Japan [3]		Tokai-mura	AMF	do		
Netherlands [3]			ACF	Tank		
Spain [3]		Madrid	GE	Pool		
Sweden [3]		Studsvik	ACF	Tank		
Venezuela [3]		Near Caracas	GE	Pool		
Federal Republic of Germany [3]		Hamburg	B. & W	do		
Do. [3]		Frankfurt	NAA	Homogeneous		

(C) Wholly or Primarily for Personnel Training

Being built: Argonne Naught Power Reactor (AEC)	Argonaut	Argonne Laboratory	ANL	Graphite	1957	

(D) Wholly or Primarily for General Testing, U. S. Locations

Operated: Materials testing reactor (AEC)	MTR	NRTS, Idaho	Fluor	Tank	1952	
Being built: Engineering test reactor (AEC)	ETR	do	KE	do	1957	
Planned:						
National Advisory Committee for Aeronautics [3]	NACA-TR	Sandusky, Ohio	NACA	do	1959	
Westinghouse testing reactor [3]	WTR	Westmoreland County, Pa.	West	do	1957	

(E) Wholly or Primarily for General Testing, Foreign Locations

Planned: Centre d'Etudes pour les applications de l'energie nucleaire of Belgium (CEAN). [3]	BR-II	Mol, Belgium	NDA		1959	

(F) Wholly or Primarily for Specialized Testing

Operated:

(F) WHOLLY OR PRIMARILY FOR SPECIALIZED TESTING

Operated:						
Savannah River test pile 305 (AEC)	SR-305	Savannah River	DuPont	Graphite	1953	
Hanford 305 test reactor (AEC)	B. and W.-305	Hanford, Wash	DuPont	do	1944	
Process development pile (AEC)	PDP	Savannah River	DuPont	Heavy water	1953	
45-foot thermal test reactor (AEC)	SP	do	DuPont	Graphite	1953	
Thermal test reactor (AEC)	TTR	Hanford, Wash	GE	do	1955	
Bulk shield test facility (AEC)	BSTF	Oak Ridge	ORNL	Pool	1950	
Tower shielding facility (AEC)	TSF	do	ORNL	do	1954	
Special power excursion reactor test No. 1 (AEC)	SPERT-1	NRTS, Idaho	PPC	Heterogeneous	1955	
Kinetic experiment on water boilers No. 1 (AEC)	KEWB-1	Santa Susana, Calif	NAA	Homogeneous	1956	
Thermal test reactor (AEC)	TTR	Schenectady, N. Y	G. E	Graphite	1951	
Ground test reactor (USAF)	GTR	Fort Worth, Tex	Convair		1953	
Aircraft shield test reactor (USAF)	ASTR	do	Convair		1954	
Being built:						
Special power excursion reactor test No. 2 (AEC)	SPERT-2	NRTS, Idaho	PPC	Pressurized water	1957	
Special power excursion reactor test No. 3 (AEC)	SPERT-3	do	PPC	do	1957	
Nuclear engineering test reactor (USAF)	NETR	Dayton, Ohio	ACF		1958	
Kinetic experiment on water boilers No. 2 (AEC)	KEWB-2	Santa Susana, Calif	NAA	Homogeneous	1958	
Planned:				Pressurized water		
Food irradiation reactor (AEC)[5 6 7]	FIR	Stockton, Calif	GE		1958	
Shielding experimental facility reactor [6 7]	SEFR	NRTS, Idaho	Lockheed	Pool		
Radiation effects reactor (USAF)	RERL	Marietta, Ga				

2. CRITICAL EXPERIMENT FACILITIES AND ZERO POWER REACTORS [8]

(A) UNITED STATES LOCATIONS

Operated, later dismantled:						
Zero power reactor No. 1 (AEC)	ZPR-1	Argonne Laboratory	ANL	Water	1950	1953
Zero power reactor No. 2 (AEC)	ZPR-2	do	ANL	Heavy water	1952	1955
Zero power reactor No. 4 (AEC)	ZPR-4	do	ANL	Water	1953	1956
Army package power reactor, critical (AEC)	APPR-OR	Oak Ridge	ORNL	Pressurized water	1955	1956
X-10 critical	X-10-200	do	ORNL	Homogeneous	1946	1948
Operated:						
Zero power reactor No. 3 (AEC)	ZPR-3	NRTS, Idaho	ANL		1955	
ORNL critical experiment facility No. 1 (AEC)	ORNL-1	Oak Ridge	ORNL		1950	
ORNL critical experiment facility No. 2 (AEC)	ORNL-2	do	ORNL		1950	
Fast exponential experiment (AEC)	FEE	Argonne Laboratory	ANL		1954	
Physical constants test reactor (AEC)	PCTR	Hanford, Wash	GE		1955	
PWR flexible critical assembly (AEC)	PWR-FA	Pittsburgh, Pa	West		1954	
PWR mockup (AEC)	PWR-Mockup	do	West		1954	
2 regional critical experiment (AEC)	TRX	do	West		1953	
Preliminary pile assembly (AEC) [9]	PPA	Schenectady, N. Y	GE		1948	
Spare plate critical assembly (AEC)	SPCA	Pittsburgh, Pa	West			
Danger coefficient test facility (AEC)	DCTF	do	West			
Flexible plastic reactor (SAR) (AEC)	FPR	Schenectady, N. Y	GE			
Flexible critical experiment (AEC)	SIC-FC	Windsor, Conn	GE			
Evendale critical experiment facility (USAF)	GEANP-1	Evendale, Ohio	GE		1956	
APPR criticality assembly (AEC)	APPR-8	Schenectady, N. Y	Alco		1954	
Reactivity measurement facility (AEC)	RMF	NRTS, Idaho	PPC		1956	
Zero power reactor No. 5 (AEC)	ZPR-5	Argonne Laboratory	ANL			

Footnotes at end of table, p. 130.

A. Low temperature (not useful for power generation)—Continued

(A) UNITED STATES LOCATIONS—Continued

Name and/or owner	Designation	Location	Builder	Type	Startup	Dismantled
Being built:						
Evendale critical experiment facility No. 2 (USAF)	GEANP-2	Evendale, Ohio	GE			
CANEL Nuclear physics laboratory (USAF)	CANEL-1	Middletown, Conn	P. and W			
Babcock & Wilcox Co		Lynchburg, Va	B. and W		1957	
Battelle Memorial Institute	BMI-CX	West Jefferson, Ohio			1957	
General Electric Co		Near Livermore, Calif	GE		1957	
Nuclear Development Corporation of America	NDA-CX	Pawling, N. Y	NDA		1957	
Planned:						
Low power test facility (AEC)[2] [10]	LPTF	NRTS, Idaho	GE			
Lockheed Aircraft Co.[2] [3]		Palo Alto, Calif			1957	
Westinghouse Electric Corp.[2] [3]		Westmoreland County, Pa	West		1957	
The Glenn L. Martin Co.[2] [3]		Middle River, Md	Martin		1957	
General Atomic Division of General Dynamics Corp.[2] [3]		San Diego, Calif	GDC		1957	
Zero power reactor No. 6 (EAC)	ZPR-6	Argonne Laboratory	ANL			

(B) FOREIGN LOCATIONS

Planned: Denmark [2]	Roskilde [3]	NAA			1957	

3. PRODUCTION REACTORS, ALL OWNED BY AEC

Operated	B reactor	Hanford, Wash	Du Pont	Graphite		
	D reactor	do	Du Pont	do		
	F reactor	do	Du Pont	do		
	C reactor	do	GE	do		
	DR reactor	do	GE	do		
	H reactor	do	GE	do		
	KE reactor	do	GE	do		
	KW reactor	do	GE	do		
	R reactor	Savannah River, S. C	Du Pont	Heavy water		
	P reactor	do	Du Pont	do		
	K reactor	do	Du Pont	do		
	L reactor	do	Du Pont	do		
	C reactor	do	Du Pont	do		

[1] To be sold and transferred in 1957 to the U. S. Naval Postgraduate School, Monterey, Calif.
[2] License application received by AEC.
[3] Publicly announced.
[4] Geneva Conference Reactor, which is being rebuilt at another location in Switzerland.
[5] Export license application received by AEC.
[6] Approved as basis for AEC contract negotiations.
[7] Authorized by Congress.
[8] Critical experiments at Los Alamos and other weapons sites not included.
[9] Formerly located at Sacandago, N. Y.
[10] Contract awarded by AEC.

B. High temperature power-producing reactors

4 (A). MILITARY PROTOTYPES AND EXPERIMENTS ALL OWNED BY AEC

Name	Designation	Location	Builder	Type	Start-up
Operated, later dismantled:					
Aircraft reactor experiment	ARE	Oak Ridge	ORNL		
Operated:					
Naval reactor test facility	S1W	NRTS, Idaho	West	Pressurized water	1953
Submarine intermediate reactor, mark A.	S1G	West Milton, N. Y.	GE	Sodium	1955
Heat transfer reactor experiment No. 1.	HTRE-1	NRTS, Idaho	GE		1956
Being built:					
Army package power reactor No. 1.	APPR-1	Fort Belvoir, Va	Alco	Pressurized water	1957
Large ship reactor prototype (2 reactors).	A1W	NRTS, Idaho	West	do	
Submarine advanced reactor.	S3G	West Milton, N. Y.	GE	do	
Heat transfer reactor experiment No. 2.	HTRE-2	NRTS, Idaho	GE		
Aircraft reactor test	ART	Oak Ridge	ORNL		
Small submarine reactor prototype.	S1C	Windsor, Conn	GE	Pressurized water	?
Planned:					
Agronne low power reactor[1]	ALPR	NRTS, Idaho	ANL	Boiling water	
Gas cooled reactor experiment.[1]	GCRE	do	AGC	Gas cooled	

[1] Publicly announced.

5. FULL SCALE MILITARY POWER (ALL OWNED BY FEDERAL GOVERNMENT)

Type of use	Designation	Designer	Type	Startup
Operated:				
Submarine U. S. S. *Nautilus*	SSN571	West	Pressurized water	1955
Submarine *Seawolf*	SSN575	GE	Sodium	1956
Being built:				
Submarine *Skate*	SSN578	West	Pressurized water	
Submarine *Swordfish*	SSN579	West	do	
Submarine *Sargo*	SSN583	West	do	
Submarine *Seadragon*	SSN584	West	do	
Submarine *Skipjack*	SSN585	West	do	
Submarine *Triton* (2 reactors)	SSN586	GE	do	
Submarine *Halibut*	SSN587	West	do	
Planned:				
Army package power reactor (Alaska) [1]	APPR-1a	Alco	do	
6 submarines[1]		West	do	
Frigate (2 reactors)[1]	CLGN-F1W	West	do	
Aircraft carrier (8 reactors)[1]	CVA(N)	West	do	

[1] Publicly announced.

Export license application received by AEC.

B. High temperature power producing reactors

6. CIVILIAN POWER REACTOR EXPERIMENTS (ALL OWNED BY AEC)

Name	Designation	Location	Type	Builder	Power (electric kilowatts)	Startup	Dismantled
Operated, later dismantled:							
Boiling reactor experiment No. 1	BORAX-1	NRTS, Idaho	Boiling water	ANL	(1)	1953	1954
Boiling reactor experiment No. 2 (modified to BORAX-3).	BORAX-2	do	do	ANL	(1)	1954	1955
Los Alamos fast reactor	Clementine	Los Alamos	Liquid metal	LASL	(1)	1946	1953
Homogeneous reactor experiment No. 1	HRE-1	Oak Ridge	Aqueous homogeneous	ORNL	140	1952	1954
Boiling reactor experiment No. 3 (modified to BORAX-4).	BORAX-3	NRTS, Idaho	Boiling water	ANL	3,400	1955	1956
Operated:							
Experimental breeder reactor No. 1	EBR-1	do	Fast breeder	ANL	200	1951	
Los Alamos power reactor experiment No. 1	LAPRE-1	Los Alamos	Aqueous homogeneous	LASL	(1)	1956	
Experimental boiling water reactor	EBWR	Argonne Lab	Boiling water	ANL	5,000	1956	
Boiling reactor experiment No. 4	BORAX-4	NRTS, Idaho	do	ANL	2,000	1956	
Being built:							
Sodium reactor experiment	SRE	Santa Susana, Calif	Sodium graphite	NAA	6,000	1957	
Organic moderated reactor experiment	OMRE	NRTS, Idaho	Organic moderated	NAA	(1)	1957	
Homogeneous reactor experiment No. 2	HRE-2	Oak Ridge	Aqueous homogeneous	ORNL	300-1,000	1957	
Los Alamos power reactor experiment No. 2	LAPRE-2	Los Alamos	do	LASL	(1)	1957	
Planned:							
Los Alamos molten plutonium reactor experiment No. 1.[2]	LAMPRE-1	do	Fast molten plutonium	LASL	(1)	1958	
Experimental breeder reactor No. 2[2]	EBR-2	NRTS, Idaho	Fast breeder	ANL	(1)	1959	
Liquid metal fuel reactor experiment[2]	LMFRE		Liquid metal	B. & W.	(1)	1960	
Argonne boiling reactor facility[2]	ARBOR	NRTS, Idaho	Boiling water		(1)	1959	
Plutonium recycle reactor experiment[2]	PURRE	Hanford, Wash	Heavy water	GE	(1)		

7 (a). FULL SCALE CIVILIAN POWER REACTORS (AEC POWER DEMONSTRATION REACTOR PROGRAM)

Name and/or owner	Location	Builder	Type	Power (electric kilowatts)	Startup
Being built: Power Reactor Development Co., Inc.	Monroe, Mich.	PRDC	Fast Breeder	100,000	1960
Planned:					
Yankee Atomic Electric Co.[2]	Rowe, Mass.	West.	Pressurized water	134,000	1960
Consumers Public Power District [4]	Beatrice, Nebr.	NAA	Sodium graphite	75,000	1960
Rural Cooperative Power Association [4]	Elk River, Minn.	AMF	Boiling water	[5] 22,000	1960
Wolverine Electric Cooperative [4]	Hersey, Mich.	F-W	Aqueous homogeneous	[5] 10,000	1960-61
Chugach Electric Association, Inc., and Nuclear Development Corp. of America.[4]	Anchorage, Alaska	NDA	Sodium, heavy water	10,000	1962
City of Piqua, Ohio [4]	Piqua, Ohio	NAA	Organic moderated	12,500	1960

7 (b). FULL SCALE CIVILIAN POWER REACTORS UNITED STATES LOCATIONS (OTHER THAN POWER DEMONSTRATION PROGRAM)

Name and/or owner	Designation	Location	Builder	Type	Power (electric kilowatts)	Builders startup estimate
Being built:						
General Electric Co. and Pacific Gas & Electric Co.		Near Livermore, Calif.	GE	Boiling water	3,000	1958
AEC and Duquesne Light Co. (AEC)	PWR	Shippingport, Pa.	West.	Pressurized water	60,000	1957
Commonwealth Edison Co. (nuclear power group)		Dresden, Ill.	GE	Boiling water	180,000	1960
Consolidated Edison Company of New York		Indian Point, N. Y.	B. & W.	Pressurized water	[6] 250,000	1960
Planned:						
Nuclear merchant ship reactor (AEC) [3]	MSR	Shipboard	B. & W.	Pressurized water	16,400	1960
Pennsylvania Power & Light Co.[2]		Eastern Pennsylvania	West.	Aqueous homogeneous	150,000	1962
Florida Power Corp., Florida Power & Light Co., and Tampa Electric Co.[2]		Florida			200,000	1962
New England Electric System [2]					200,000	1964
Carolina-Virginia Nuclear Power Associates, Inc.[2]					10,000-30,000	
Middle South Utilities, Inc.[2]					20,000	

Footnotes at end of table, p. 134.

B. High temperature power producing reactors—Continued

7 (c). FULL SCALE CIVILIAN POWER REACTORS, FOREIGN LOCATIONS

Location	Owner	Builder	Type	Power (electric kilowatts)
Planned:				
Belgium [3]	Syndicat d'Etude de l'Energie Nucleaire (SEEN)	West	Pressurized water	11,500
Dominican Republic [2 3]	Dominican Republic	Martin	do	12,000
Latin America (Brazil) [2 3]	American & Foreign Power Co	GE	Boiling water	10,000
Latin America (Cuba) [2 3]	do	GE	do	10,000
Latin America (Mexico) [2 3]	do	NAA	Organic moderated	10,000
Philippines (Manila) [2 3]	General Public Utilities Corp	West	Pressurized water	134,000
Italy (Milan) [2 3]	Edisonvolta			

[1] No electric.
[2] Publicly announced.
[3] Contract awarded by AEC.
[4] Approved as a basis for AEC contract negotiations.
[5] Represents total output of plant, about 20 percent of which will be nonnuclear.
[6] 140,000 nuclear; 110,000 oil fired.
[7] Approved as a basis for AEC contract negotiations.
[8] Bilateral agreements for cooperation prerequisite to supplying these reactors have not been executed.

TABLE Ib

POWER REACTORS

Government-sponsored project

Name	Pressurized Water Reactor.
Location	Shippingport, Pennsylvania.
Contractors	Westinghouse Electric Corp. and Duquesne Light Co.
Heat output	236,000 kilowatts.
Electrical generating capacity	100,000 kilowatts.
Amount of fuel	12 tons natural uranium, and 52 kilograms enriched.
Enrichment, percent U–235	About 90 percent.
Moderator	H_2O.
Coolant	H_2O.
Reactor outlet temperature	540° F.
Reactor pressure	2,000 psi.
Steam conditions	585 psi at 486° F.
Control method	Control rods.
Start of construction	1954 (September)
Reactor critical	Late 1957.
Full power operation	Not available.
Total estimated plant cost [1]	Approximately $55,000,000.
Cost per kilowatt	$550.
Actual research and development costs for fiscal year 1956	$33,119,000.
Estimated research and development costs for fiscal year 1957	$11,000,000.

[1] Includes $5 million investment by Duquesne in the project and $10 million for the turbogenerator plant which Duquesne is providing. Excludes $0.5 million which Westinghouse has contributed to the project.

First round power demonstration projects

	Yankee Atomic Electric Co.[1]	Consumers Public Power District [2]	Power Reactor Development Co.[2]
Location	Rowe, Mass	Beatrice, Nebr	Monroe, Mich.
Type of reactor	Pressurized water	Sodium graphite	Fast breeder.
Heat output	480,000 kw	245,000 kw	300,000 kw.
Electrical generating capacity	134,000 kw	75,000 kw	100,000 kw.
Amount of fuel	28,800 kg	22,500 kg	2,100 kg.
Enrichment, percent U–235	2.5 percent	2.3 percent	27 percent.
Moderator	H_2O	Graphite	None.
Coolant	H_2O	Sodium	Sodium.
Reactor outlet temperature	535° F	925° F	800° F.
Reactor pressure	2,000 psi	46 psi	14.7 psi.
Steam conditions	600 psi at 489° F	800 psi at 825° F	600 psi at 730° F.
Total estimated plant cost [3]	$34,500,000	$24,300,000 [4]	$45,000,000.
Cost per kilowatt	$260	$325	$450.
Estimated completion date	1960	1960	1960.

[1] Contract signed.
[2] Contracts under negotiation.
[3] Excludes research and development.
[4] Original cost estimate; proposer has indicated that cost estimates may be revised upward.

Second round power demonstration projects

	Rural Cooperative Power Association [1]	Wolverine Electric Cooperative [1]
Location	Elk River, Minn.	Hersey, Mich.
Type of reactor	Boiling water	Aqueous, homogeneous.
Heat output	58,000 kw	38,000 kw.[2]
Electrical generating capacity	22,000 kw	10,000 kw.
Amount of fuel	14.1 kg enriched; 11,750 kg normal	12 kg.
Enrichment, percent U-235	Fully enriched spikes, natural U core.	Fully enriched.
Moderator	H_2O	Uranyl sulfate in heavy water.
Coolant	H_2O	Circulating fuel.
Reactor outlet temperature	533° F	570° F.
Reactor pressure	900 psi	1,900 psi.
Steam conditions	600 psi at 825° F	600 psi at 486° F [3]
Total estimated plant cost [4]	$6,185,000 [5]	$3,574,000. [5]
Cost per kilowatt	$281	$357.
Estimated completion date	1960	1959.

[1] Contracts under negotiation.
[2] Includes superheater, 7,000 kw.
[3] Steam from heat generator to gas-fired superheater.
[4] Excludes research and development.
[5] Original cost estimate; proposer has indicated that cost estimates may be revised upward.

	Chugach Electric Association [1]	City of Piqua, Ohio [1]
Location	Anchorage, Alaska	Piqua, Ohio.
Type of reactor	Sodium-cooled, heavy-water moderated.	Organic moderated.
Heat output	40,000 kw	45,500 kw.
Electrical generating capacity	10,000 kw	12,500 kw.
Amount of fuel	10,000 kg	6,000 kg.
Enrichment, percent U-235	Approximately 2 percent	3 percent.
Moderator	Heavy water	Terphenyl.
Coolant	Liquid solium	Do.
Reactor outlet temperature	950° F	617° F.
Reactor pressure	14.7 p. s. i.	50 p. s. i.
Steam conditions	850 p. s. i. at 850° F	400 p. s. i. at 550° F.
Total estimated plant cost [2]	$7,350,000	$7,965,000.
Cost per kilowatt	$735	$637.
Estimated completion date	1962	1960.

[1] Contracts under negotiation.
[2] Excludes research and development.

Independent industrial projects

	Consolidated Edison Co.	Commonwealth Edison and others	Westinghouse Electric Corp. and Pennsylvania Power & Light	General Electric, Pacific Gas & Electric
Location	Indian Point, N. Y.	Dresden, Ill.	Eastern Pennsylvania.	Vallecitos, Calif.
Type of reactor	Pressurized water.	Boiling water.	Aqueous homogeneous.	Boiling water.
Heat output	500,000 kw	630,000 kw	Not available	12,000 kw.
Electrical generating capacity	140,000 kw.[1]	180,000 kw	150,000 kw	3,000 kw.
Amount of fuel	275 kg. U and 8,275 kg. Th.	68,000 kg	Not available	30 kg.
Enrichment, percent U-235	About 90 percent for U.	1.1 percent	do	90 percent.
Moderator	H_2O	H_2O	do	H_2O.
Coolant	H_2O	H_2O	Fuel slurry	H_2O.
Reactor outlet temperature	510° F	480° F	Not available	Not available.
Reactor pressure	1,500 p. s. i.	1,000 p. s. i.	do	Do.
Steam conditions	370 p. s. i. at 1,000° F.	970 p. s. i. at 540° F.	do	Do.
Total estimated plant cost [2]	$55,000,000	$45,000,000	do	Do.
Cost per kilowatt	$230	$250	do	Do.
Estimated completion date	1960	1960	1962	1957.

[1] Excludes 96,000 kilowatts of conventional superheating capacity.
[2] Excludes research and development.

AEC experimental projects

BOILING WATER TYPE [1]

Reactor project	BORAX-4 (boiling reactor experiment)	BWRE (boiling water reactor experiment)	ARBOR (Argonne boiling reactor)
Location	NRTS, Idaho	Argonne	NRTS, Idaho.
Responsible laboratory	Argonne	do	Argonne.
Heat output	8,000 kw	20,000 kw	200,000 to 600,000 kw.
Electrical generating capacity	2,000 kw	5,000 kw	None.
Amount of fuel	Not available	4,500 kg	Varies.
Enrichment, percent U-235	About 90 percent	1.4 percent	Do.
Moderator	H_2O	H_2O	H_2O.
Coolant	H_2O	H_2O	H_2O.
Reactor outlet temperature	419° F	488° F	636° F.
Reactor pressure	300 p. s. i.	600 p. s. i.	2,000 p. s. i. maximum.
Steam conditions	285 p. s. i. at 415° F	560 p. s. i. at 479° F	2,000 p. s. i. at 637° F.
Control method	Control rods	Control rods	Control rods.
Start of construction	1956 (April)	1955 (May)	1957 (January).
Reactor	1956 (December)	1956 (December)	1959 (August).
Full power operation	do	do	1959 (September).
Cost of reactor [2]		$4,434,000	$8,500,000.

[1] Research and development costs on boiling water type: Actual through fiscal year 1956, $11,036,000; estimated for fiscal years 1957-60, $19,800,000.
[2] BORAX-3 facility used.

HOMOGENEOUS REACTOR TYPE [3]

	HRE-1 (Homogeneous reactor experiment No. 1) [4]	HRE-2 (Homogeneous reactor experiment No. 2)	LAPRE-1 (Los Alamos reactor experiment No. 1) [4]	LAPRE-2 (Los Alamos reactor experiment No. 2)
Location	Oak Ridge	Oak Ridge	Los Alamos	Los Alamos.
Responsible laboratory	do	do	do	Do.
Heat output	1,000 kw	5,000 kw	2,000 kw	1,000 kw.
Electrical generating capacity.	140 kw	300 kw	None	None.
Amount of fuel	2 kg	5.2 kg	4.25 kg	3.85 kg.
Enrichment, percent U-235.	About 90 percent	About 90 percent	About 90 percent	About 90 percent.
Moderator	H_2O	H_2O	H_2O	H_2O.
Coolant	Circulating fuel solution.	Circulating fuel solution.	H_2O	H_2O.
Reactor outlet temperature.	482° F	572° F	800° F	600° F.
Reactor pressure	1,000 psi	2,000 psi	About 3,900 psi	About 800 psi.
Steam conditions	200 psi at 380° F	520 psi at 474° F	3,600 psi	600 psi at 492° F.
Control method	U concentration and temperature coefficient.	U concentration and temperature coefficient.	Solution volume, temperature coefficient, and control rods.	Solution volume, temperature coefficient, and control rods.
Start of construction	1950 (September)	1954 (July)	1954 (September)	1955 (February).
Reactor critical	1952 (April)	1957	1956 (February)	1957.
Full power operation	1953 (February)	1957	1957	1957.
Cost of reactor	$1,100,000	$3,008,000	$700,000	$100,000.

[3] Research and development costs on homogeneous reactor type: Actual through fiscal year 1956, $27,081,000; estimated for fiscal year 1957 on HRE-2 and LAPRE-2, $10,400,000.
[4] Experiment completed.

AEC experimental projects—Continued

FAST POWER BREEDER REACTOR TYPE [5]

Reactor project	EBR–1 (experimental breeder reactor No. 1)	EBR–2 (experimental breeder reactor No. 2)	LAMPRE–1 (Los Alamos molten plutonium reactor experiment)
Location	NRTS, Idaho	NRTS, Idaho	Los Alamos.
Responsible laboratory	Argonne	Argonne	Do.
Heat output	200 kw	62,500 kw	About 1,000 kw.
Electrical generating capacity	200 kw	15,000 kw	None.
Amount of fuel	52 kg	210 kg	10–15 kg.
Enrichment, percent, U–235	About 90 percent	60 percent	None.
Moderator	None	None	None.
Coolant	Sodium-potassium	Sodium	Sodium-potassium.
Reactor outlet temperature	600° F	900° F	Not available.
Reactor pressure	About 15 psi	50 psi	Do.
Steam conditions	400 psi at 525° F	1,250 psi at 850° F	None.
Control method	Movable blanket and U–238 rods.	Movable blanket and fuel rods.	Movable reflector.
Start of construction	1949 (fall)	1957 (July)	1956 (November).
Reactor critical	1951 (August)	1959 (June)	1957.
Full power operation	1951 (February)	1959 (December)	1957.
Cost of reactor	$2,732,000	$15,280,000	Not available.

[5] Research and development costs on fast power breeder type: Actual through fiscal year 1956, $14,746,000; estimated for fiscal years 1957–59, $45,300,000.

OTHER TYPES

Reactor project	SRE (sodium reactor experiment)	OMRE (organic moderated reactor experiment)	LMFRE (liquid metal fuel reactor experi-experiment)
Location	Santa Susana, Calif.	NRTS, Idaho	Not selected.
Contractor	North American Aviation.	North American Aviation.	Babcock & Wilcox.
Heat output	21,000 kw	5,000–16,000 kw	20,000 kw.
Electrical generating capacity	6,000 kw	None	None.
Amount of fuel	2,570 kg	20.75 kg	Not available.
Enrichment, percent U–235	2.8 percent	About 90 percent	Fully enriched.
Moderator	Graphite	Diphenyl	Graphite.
Coolant	Sodium	do	Circulating fuel solution.
Reactor outlet temperature	960° F	710° F	1,000° F.
Reacture pressure	3 psi	300 psi	14.7 psi.
Steam conditions	600 psi at 825° F	None	2,000 psi at 950° F.
Control method	Control rods	Control rods	Temperature coefficient rods.
Start of construction	1954 (July)	1956 (June)	Not available.
Reactor critical	1957 (February)	1957 (May)	Do.
Full power operation	1957 (June)	1957 (July)	1959.
Cost of reactor	$6,850,000	$1,706,000	$10,000,000–$15,000,000.
Actual research and development costs through fiscal year 1956.	$7,405,000	$385,000	$1,601,000.
Estimated research and development costs for fiscal year 1957.	$4,864,000	$3,863,000	Not available.

TABLE 1c

AEC research reactors [1]

Laboratory and reactor	Type	Power (kw. heat)	Typical thermal neutron flux (per sq. cm. per sec.)	Fuel	Coolant	Initial operation
Brookhaven:						
Research reactor	Graphite	30,000	5×10^{12}	42.5 tons natural U	Air	1950
Medical reactor	Tank	1,000	5×10^{10}	4 kg. U–235	Water	1957
Oak Ridge:						
Graphite reactor (X–10)	Graphite	3,800	1.1×10^{12}	47.6 tons natural U	Air	1943
Research reactor	Tank	20,000	1.2×10^{14}	3.7 kg. U–235	Water	1957
Low intensity test reactor	do	2,000	4×10^{12}	3 kg. U–235	do	1950
Bulk shielding reactor	Pool	100	2×10^{12}	3.5 kg. U–235	do	1950
Argonne. CP–5 research reactor	Heavy water	1,000	1.7×10^{12}	1.3 kg. U–235	Heavy water	1954
Los Alamos: SUPO water boiler	Water boiler	45	1.7×10^{12}	980 gm. 88.7 percent U–235 as $UO_2(NO_3)_2$	Water	1951
University of California Radiation Laboratory:						
Water boiler reactor	do	.5	2×10^{10}	694 gm. U–235 as UO_2SO_3	do	1953
Livermore pool type reactor	Pool	1,000	10^{13}	3.3–5.0 kg. U–235	do	1957
National Reactor Testing Station:						
Materials testing reactor	Tank	30,000	2×10^{14}	4 kg. U–235	do	1952
Engineering test reactor	do	175,000	4×10^{14}	12 kg. U–235	do	1957

[1] Excludes projects now in preliminary planning stage and other small reactor and zero-power assemblies designed primarily to provide data for specific reactor projects.

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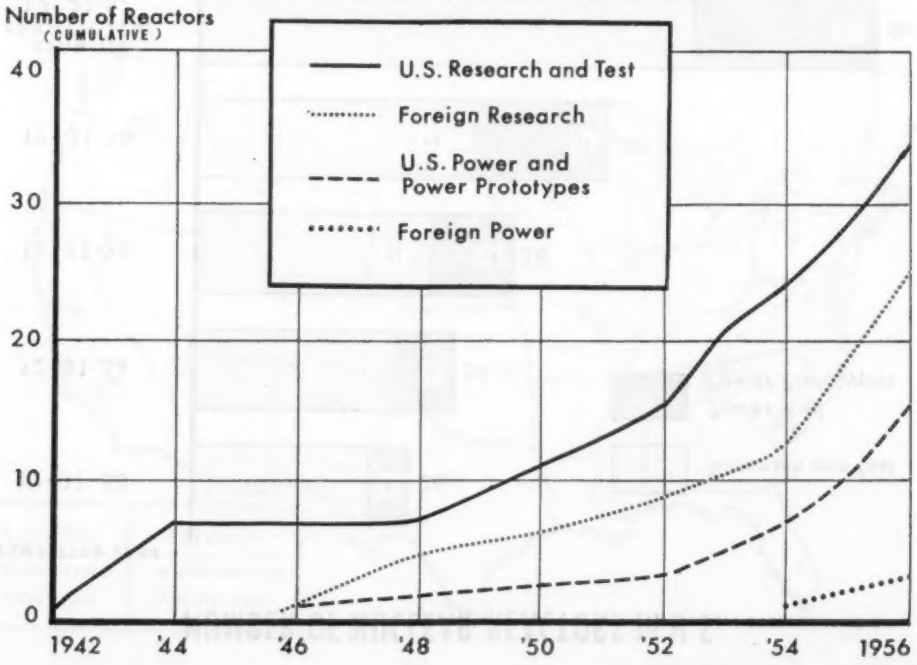
Other research reactors [1]

Owner	Type	Power (kw. heat)	Typical thermal neutron flux (per sq. cm. per sec.)	Fuel	Coolant	Initial operation
North Carolina State College, Raleigh, N. C	Homogeneous	10	2×10^{11}	1,150 gm. U–235 as UO_2SO_4	Water	1953
Pennsylvania State University, University Park, Pa	Pool	100	10^{12}	3.5 kg. U–235	do	1955
University of Michigan, Ann Arbor, Mich	do	1,000	10^{13}	3.1 kg. U–235	do	1956
Naval Research Laboratory, Washington, D. C	do	100	10^{13}	5.0 kg. U–235	do	1956
Armour Research Foundation, Chicago, Ill	Water boiler	50	$1.70X10^{12}$	950 gm. U–235 as UO_2SO_4	do	1956
Battelle Memorial Institute, Columbus, Ohio	Pool	1,000	7×10^{12}	5.1 kg. U–235	do	1956
Massachusetts Institute of Technology, Cambridge, Mass	Tank	1,000	10^{13}	1.8 kg. U–235	Heavy water	1957–1959
Government of Switzerland	Pool	100	10^{11}	3.5 kg. U–235	Water	1955
Aerojet-General Nucleonics, San Ramon, Calif	Polyethylene moderated.	.0001	4.5×10^{6}	656 gm. U–235	Polyethylene	1956

[1] Except for the Swiss reactor, includes only those projects for which facility license or construction permit has been issued.

CHART I

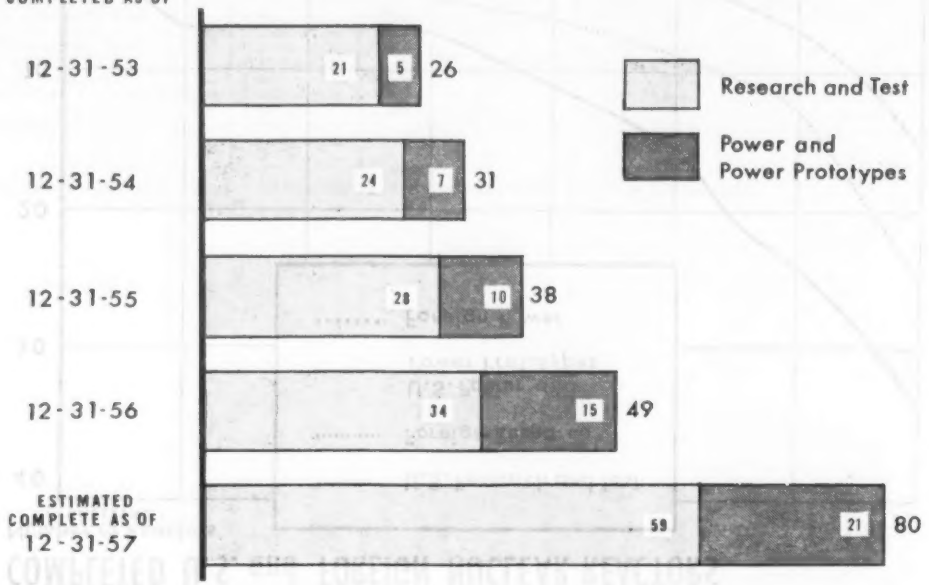
COMPLETED U.S. and FOREIGN NUCLEAR REACTORS



Division of Reactor Development - January 1957

CHART II

NUMBER OF NUCLEAR REACTORS in U.S. (CUMULATIVE)



Division of Reactor Development - January 1957

CHART III

RESEARCH and TEST REACTORS, U.S.

DECEMBER 31, 1956

Division of Reactor Development - January 1957

CHART IV

REACTOR FAMILIES – Related Civilian Power and Military Reactors

PRESSURIZED WATER REACTORS

CIVILIAN

1 - PWR - Westinghouse Electric Corp.
Duquesne Light Co.
2 - Consolidated Edison Co.
3 - Yankee Atomic Electric Co.
4 - Nuclear Merchant Ship
5 - PURRE - Plutonium Recycle

MILITARY

6 - STR - Westinghouse Electric Corp.
7 - SAR - General Electric Co.
8 - SRS - Combustion Engineering Co.
9 - LSR - Westinghouse Electric Corp.
10 - APPR - ALCO Products, Inc.

SODIUM COOLED REACTORS

• THERMAL

CIVILIAN - 1 - SRE - North American Aviation, Inc.
Southern Calif. Edison Co.
2 - Consumers Public Power District
3 - Chugach Electric Association, Inc.
and Nuclear Development Corp. of America

• INTERMEDIATE

MILITARY - 4 - SIR - General Electric Co.

• FAST

CIVILIAN - 5 - EBR-1 - Argonne National Laboratory
6 - EBR-2 - Argonne National Laboratory
7 - LAMPRE - Los Alamos Scientific Laboratory
8 - Power Reactor Development Co., Inc.
(Detroit Edison Co. and others)

BOILING WATER REACTORS

CIVILIAN

1 - BORAX-4 - Argonne National Laboratory
2 - EBWR - Argonne National Laboratory
3 - ARBOR - Argonne National Laboratory
4 - Commonwealth Edison Co.
5 - Rural Cooperative Power Association
6 - General Electric Co. and Pacific Gas
and Electric Co.

MILITARY

7 - ALPR - Argonne National Laboratory

FLUIDIZED REACTORS

• AQUEOUS HOMOGENEOUS

CIVILIAN - 1 - HRE-2 - Oak Ridge National Laboratory
2 - LAPRE-2 - Los Alamos Scientific Laboratory
3 - Pennsylvania Power & Light Co.
4 - Wolverine Electric Cooperative

• LIQUID METAL FUELED

CIVILIAN - 5 - LMFRE - Babcock & Wilcox

ORGANIC MODERATED REACTORS

CIVILIAN

1 - OMRE - North American Aviation, Inc.
2 - City of Piqua, Ohio

GAS COOLED REACTORS

MILITARY - CIVILIAN
1 - GCRE - Aerojet General Corporation

Division of Reactor Development - January 1957

IX. Regulation and Licensing of the Atomic Energy Industry

Summary of applications for and licenses issued during 1956

The year 1956 saw significant advances in private participation in the atomic-energy field as evidenced by licenses applied for and issued.

Construction permits were issue to three firms authorizing construction of large developmental power reactors. A fourth company was authorized to construct a smaller developmental facility which also will produce electrical energy for distribution.

Four organizations were authorized by license to commence operation of research reactors. There are now six privately owned reactors licensed for operation.

The applications filed in 1956 included the proposed construction of a total of 19 research reactors and 6 critical experiment facilities. Of these, 1 reactor manufacturing firm completed the construction and initial testing of its first small, self-contained research reactor and applied for authorization to build 8 additional reactors of the same type for sale to universities and other potential purchasers. Late in the year another manufacturer filed an application for authorization to build the prototype of a research reactor which it plans to produce in quantity for sale to licensed institutions.

American firms filed 5 license applications during 1956 for the export of research reactors. These reactors are proposed for shipment to West Germany, the Netherlands, Italy, Brazil, and Japan under bilateral agreements for cooperation. The license covering the reactor for Japan has been issued and part of the reactor has been shipped. Notices have been published of the proposed issuance of export licenses covering the reactors for Brazil and the Netherlands. All of these applications were received during the last half of the year.

The licenses issued and applied for in 1956 are listed in the 20th semiannual report at pages 28 and 29 and in appendix 8 of the 21st report, pages 329 to 335. The listing in the reports is alphabetical for convenience in following the types of activity licensed. This testimony gives a breakdown by types as noted below.

A recapitulation of the facility license applications filed since the enactment of the 1954 act is shown in table I attached.

The first privately owned plant for the production of enriched uranium oxide commenced operations in 1956 under a special nuclear material license issued by the Commission. Special nuclear material licenses were issued to 8 other companies who are in business fabricating enriched uranium fuel elements or processing enriched uranium for ultimate fabrication into fuel elements. These companies are identified in table II attached.

The number of special nuclear material license applications increased substantially in 1956 over the number filed the previous year. Over 50 such applications were filed and approved, more than 3 times as many as in 1955. The special nuclear material licenses applied for and actions taken are listed in the 20th semiannual report, pages 30 to 33, and in appendix 9 of the 21st semiannual report, pages 332 to 335. Some of the licenses authorized fuel preparation and fabrication. Other activities authorized included research and development work on fuel materials, manufacture of fission counters, radiation chemistry experiments, and application of isotopic dilution techniques.

During 1956 over 17,000 kilograms of uranium 235 were allocated to over 30 licensees for use in connection with licensed research and development activities, including the material allocated for use as fuel in the operation of nuclear reactors authorized for construction or operation.

The number of such projects is indicative of industry's growing activity in the atomic-energy field, bearing in mind that many of the projects for which applications were received in 1956 necessarily had to be preceded by extensive planning on the part of the applicants concerned, and considering also that 1956 was only the second year of the licensing program.

As the Joint Committee is aware, following the issuance of the construction permit to the Power Reactor Development Co., petitions for leave to intervene and for further relief were filed with the Commission by the International Union, United Automobile, Aircraft and Agricultural Implement Workers of America, AFL–CIO; International Union of Electrical, Radio and Machine Workers, AFL–CIO; and International Union, United Paper Workers of America, AFL–CIO. The hearing requested by the petitioners was granted by the Commission. Mr. J. A. Kyle, of the Federal Communications Commission, was designated as the presiding officer for the hearing. The hearings began in January 1957, and are continuing.

Radiation safety in licensed activities

AEC organization for hazards evaluation.—Evaluation of the hazards aspects of proposed nuclear facilities constitutes the basic element of the licensing process. The Commission has brought together during the past year a key technical staff, composed of nuclear physicists and engineers, who, with the aid of other specialists within the Commission are performing this important function.

The hazards evaluation staff performs critical safety analyses of all nuclear facilities, both Government-owned and those proposed for licensing, and identifies those additional specifications that must be met in order to give reasonable assurance that construction and operation of the proposed facility at its proposed site will not endanger the health and safety of the public. This staff also is responsible for developing standards, guides, and specifications for the safe design, construction, and operation of nuclear facilities and for conducting corollary studies in these fields.

The key staff is being augmented by scientists and engineers possessing skills in specialized fields of nuclear technology. As a long-range measure to cope with the shortage of scientific and technical people, young graduates of nuclear training programs have been recruited and others with suitable college preparation have been obtained and placed in training programs.

The review and evaluation of the hazard aspects of some 50 critical assemblies and research and power reactors have been undertaken. These include military, commission, and licensed reactors. The workload continues to grow, and in addition to the full-time technical staff, and as the need arises, the Commission also utilizes the services of consultants having special knowledge in particular areas of reactor safety.

The Advisory Committee on Reactor Safeguards continues to render invaluable service to the Commission in the hazards evaluation work. During 1956 the main Committee held four meetings dealing with various phases of a number of specific reactor projects and technical programs. In addition, two subcommittee sessions were held to deal with similar work.

In this period of early development of the civilian application program, it has been necessary to call upon the Committee for advice and assistance on most proposed reactor projects. However, as the Commission's own technical staff is expanded to the required strength and a reactor type becomes standardized, demands upon the Advisory Committee for advice on specific projects will lessen. Thus, the Committee's assistance can be directed more and more to the exceptionally difficult or unusual cases and to the development of safety standards and criteria. The Commission also will continue to utilize the services of individual members for consultation in their particular fields of competence as desirable on specific questions and projects.

Development of standards and criteria for safety of nuclear facilities.—There is at present only a limited amount of systematic, generally accepted material available with respect to safety criteria and standards for design and operation of nuclear facilities. There is still not complete agreement in the general community of nuclear engineers with respect to what is required and the bases upon which safety is judged. It is most urgent, therefore, that general standards and guides for various types of nuclear facilities be developed as soon as possible. A beginning has been made in this direction but much more needs to be done. It is the present expectation, however, that a larger portion of the effort of the Commission staff, advisers, and consultants will be devoted to this task during the coming months.

The wide range of problems involved in safe design, location, and operation of atomic industrial installations is covered in detail by part II of the 21st semiannual report, pages 109 to 260. This part places safety problems caused by possible addition of radiation from nuclear industrial plants to the natural environment in perspective along with the problems produced by medical and dental X-ray usage and weapons testing. The major discussions of the atomic industrial safety factors appear on pages 120 to 125 and 132 to 143.

Study of the potential damage which might be caused by nuclear runaway of power reactors.—As the Joint Committee has previously been informed, the Commission in August 1956 initiated a comprehensive study of the potential damage which might result from the nuclear runaway of power reactors. The study is expected to contribute to a clearer understanding of the possible scope and implications of reactor accidents.

It is expected that the first phase of this study, the general definition of the major factors which enter into the problem and orders-of-magnitude estimates of the ranges of potential damage, will be completed early in 1957. In this

preliminary phase of the study, it is hoped that the major technical deficiencies obstructing a more competent evaluation of potential damage will be identified so that efforts might be directed to resolution of such inadequacies.

The second phase of the study, which will begin as soon as the first phase is complete, is expected to encompass not only further accumulation of data and evaluation thereof but experimental investigations necessary to give more definitive answer to problems.

Industry's role in hazards evaluation.—The hazards evaluation process itself and the requirements it imposes upon the reactor builder have been described at length in earlier reports by the Commission to the Joint Committee. These have emphasized that while the responsibility rests with the Commission for the final determination that proposed nuclear reactors can be operated without undue risk to public health and safety, the burden of showing that a given facility meets this criterion rests with the license applicant. In other types of industrial activity, American industry has established a notable record of industrial safety. The substantial expenditure of technical talent and effort currently being made by license applicants to assure the reliability of their plants indicates that industry has not accepted its responsibilites in the nuclear field casually.

The technical and scientific effort entailed in the applicant's hazards evaluation of a reactor project may extend over a period of months. In the case of a large power reactor, from 2 to 3 years may be required before the design of the facility is firmed up. The hazards study includes exhaustive analyses of the characteristics of the reactor and of the environment in which it is to be located. It also requires a thorough analysis of all possibilities of operational failure or accident in order that the necessary safety systems and devices may be incorporated in the design. In many cases critical experiments, requiring the construction of a separate facility for this purpose, are necessary to develop the technical information upon which much of the hazards evaluation is based.

Equally important to safety, of course, are the procedures which the license applicant proposes to employ in the operation of his completed reactor. His description of such procedures is therefore an essential part of the hazards evaluation report upon the basis of which the Commission must judge whether the reactor can be operated safely. Much of this operational procedure must be worked out before designs can be completed and construction begun and the procedure is reevaluated many times before construction is completed and actual operations commence.

New regulations and amendments

The basic framework for the licensing of private atomic-energy activities was essentially completed early in 1956 with the publication in January and February of the regulations on the licensing of nuclear materials and facilities, operators of facilities, access to restricted data, safeguarding of restricted data, unclassified activities, in foreign atomic-energy programs, rules of practice and specifications for the granting of patent licenses. These regulations are set forth in appendix 7 of the 20th semiannual report, pages 169 to 251.

Two new and five amended regulations have since been published and explanatory matter concerning these is carried in the 21st semiannual report, pages 32 to 33. For convenience of the committee, brief summaries of these seven actions follow:

10 CFR, Part 20: Standards for Protection Against Radiation, effective February 28, 1957, establishes standards for protection against radiation hazards arising from activities licensed by the Commission. This regulation was initially published in proposed form in July 1955 and most licenses issued since that time and up to its effective date have included provisions requiring the licensee to comply with the proposed regulation. The regulation will be subject to continuing consideration in order to keep it consistent with developments in the field of radiological health and safety.

10 CFR, Part 9: Public Records, was published in November 1956 as a notice of proposed rulemaking and was made effective in December 1956. It sets further rules governing the Commission public records relating to any procedures subject to Part 2: Rules of Practice, or Part 25: Access to Restricted Data, of the Commission regulations.

The following amendments to existing regulations have been made or published as proposed rules:

10 CFR, Part 2: Rules of Practice: was amended in December 1956 to provide procedures for handling restricted data introduced in proceedings or needed

to prepare for them. The procedures are based upon section 181 of the act requiring that parallel procedures be established by regulation to safeguard restricted data or defense information.

10 CFR, Part 25: Access to Restricted Data: was amended in August 1956 to permit access to information on controlled thermonuclear processes under two special criteria. These are (*a*) that the applicant be engaged in a substantial effort to develop, design, build, or operate a fission power reactor that is planned for construction, or (*b*) that he possess qualifications demonstrating that he is capable of making a significant contribution to research and development in the thermonuclear field.

10 CFR, Part 30: Licensing of Byproduct Material: was amended in September 1956. The amendment eliminates the requirement that applications for specific byproduct material licenses must be signed under oath or affirmation. Another amendment to part 30 in October, placed certain devices containing small quantities of radioisotopes under general license, thus making possible their sale to the general public.

10 CFR, Part 50: Licensing of Production and Utilization Facilities: was amended in December 1956. The amendment declares that the Commission will not consider the making of a finding of practical value under section 102 of the act as requiring the conversion of a previously issued class 104 construction permit or license.

10 CFR, Part 55: Operators' Licenses: was amended in September 1956 to eliminate the requirements that applications for licenses must be signed under oath or affirmation.[3]

When the Commission's basic regulations were prepared, care was taken to assure that they provided reasonably flexible requirements in order not to establish a rigid regulatory pattern for an industry which was still in its formative years. Advisory groups representative of industries and others likely to be affected were freely consulted and their views and suggestions drawn upon. In the brief period the regulations have been in effect no basic problems have been reported by industry. Our experience discloses, nevertheless, the need for a number of changes which, we believe, will improve the regulations. Other revisions will doubtless prove necessary or desirable as further experience accrues.

On August 27 and 28, 1956, the Advisory Committee on Isotope Distribution met to discuss with the Commission's staff various matters pertinent to the Commission's isotopes program. The agenda included a discussion of the status and consent of those regulations being developed to prescribe standards for protection against radiation, standards for sealed sources containing byproduct material, and requirements for licensing byproduct material. There was also general discussion of the special requirements involved in high level irradiation facilities, and of the problems involved in introducing isotopes into the general environment as consumer products.

Inspection

The atomic industry of the future will obviously be affected by the activities carried on under the inspections of the act of 1954. The development of an organization, assignment of functions, and the preliminary work carried on during 1956 were reported in the 21st semiannual report, pages 91 to 92, and 129 to 131.

Cooperation with State agencies

An important aspect of the continued development of a private atomic-energy industry has been the concurrent broadening of the interest of the several States in this field. These interests stem not only from the desire of the States to foster the development of the industry within their borders but extend, as well, to the relation of licensed activities to public health and safety.

A number of governors have established councils and committees through which their States may avail themselves of new social and economic opportunities in the peaceful uses of atomic energy. Several groups of States also have joined together, on regional bases to promote positive and uniform action in their areas by sponsoring conferences, studies, and workshops at which recommended courses of action and programs can be developed. The Commission staff has been privileged to participate in many of these meetings.

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[3] Texts of regulations and amendments are printed in appendix 6, 21st Semiannual Report, pp. 284–297.

In the regulatory area, the States are naturally interested in assuring that private atomic-energy activities are conducted in a manner that protects the health and safety of the public. In recognition of this important interest, the Commission has expanded and increased its efforts to work closely with State agencies in the licensing program. Cooperative effort in this direction has taken the following forms:

Notification of licensing actions.—The Commission informs each State of licensing actions pertaining to licensees within its boundaries. These include the licensing of special nuclear material, byproduct materials, and facilities. Each State concerned also is notified of the receipt by the Commission of applications for facility licenses and, thus, is afforded the opportunity to discuss proposed projects with the Commission if it desires to do so. In this connection and as the opportunity affords applicants for facility licenses are urged to inform the appropriate agencies of their States of proposed plans involving the construction of nuclear facilities. Interested State agencies also have been placed on the Commission's public announcement mailing list further to enable them to keep abreast of the Commission's activities.

Consultation with the Advisory Committee of State Officials.—The Advisory Committee of State Officials, consisting of 12 members from health, labor, and legal departments of the States was established in 1955 as an outgrowth of the conference of governors' representatives held by AEC in July of that year. Meetings with the Committee were held in February and November of 1956 to discuss the Commission's licensing program and to obtain the Committee's suggestions and views with respect to the regulation prescribing standards for protection against radiation. Such meetings, in addition to enabling the Commission to obtain the Committee's views on regulatory questions, also serve the important purpose of promoting common understanding of problems of mutual interest to the Commission and the States.

Inviting comments on proposed regulations.—In addition to consulting the Advisory Committee on the regulation dealing with radiation protection, copies of the proposed regulation were submitted for comment to the governor and the health and labor departments of each of the States. Thus, the States were able to examine the regulation in draft form and to submit such comments and suggestions as they thought appropriate or desirable in the light of the application of the regulation to local needs and interests.

Inspecting of licensees.—Regulatory agencies of the States are being encouraged to participate with Commission inspectors in the inspection of licensees. By means of joint inspections, the States will be enabled to keep abreast of licensed activities in their areas; moreover, such inspections should provide valuable training experience for their personnel and enable both the Commission and the States to make the most effective use of the limited supply of technical and scientific personnel. The Commission is currently arranging conferences with the governors of several States for the purpose of developing a broad program of cooperation between the States and the Commission in the civilian atomic-energy program. A primary objective of these conferences is to establish a basis for utilizing available technical resources within the States in assisting the Commission in discharging its compliance inspection responsibilities for byproduct material licenses. Conferences with additional States will follow progressively.

Other meetings and conferences with local authorities.—Members of the Commission staff also have participated, during the past year, in a number of meetings and conferences with State and local authorities to discuss the regulation of private atomic-energy activities and to familiarize local authorities with the Commisson licensing and inspection programs. Meetings of this kind have contributed importantly to AEC-State cooperation in the regulatory field.

A comprehensive visitation program to the States has been initiated by the Commission. These meetings with State agencies will provide an opportunity to (1) keep the States abreast of regulatory activities of the Commission, (2) become informed of present and contemplated work of the States in the atomic-energy field, (3) evaluate the States' needs for training of personnel and determine the need for providing additional training opportunities, and (4) explore means of fully utilizing available technical resources within the States in carrying out the Commission's regulatory program.

State participation in the access program.—Those State agencies which believe they require access to restricted data in the civilian application field have been encouraged to participate in the access program and access permits have been issued to a number of State agencies for this purpose.

Training of State personnel.—The Commission is actively exploring with the Advisory Committee of State Officials the need for additional training opportunities in the field of radiological health protection to enable their personnel to become knowledgeable in this field. Based upon this need, the Commission will actively assist the States in obtaining training opportunities in this field.

Concurrently with the expansion in atomic energy activities a number of States are understood to be considering comprehensive regulations appropriate to their interests. Naturally, such regulations will have an important effect upon the growth and development of the industry and the Commission, therefore, believes that it is in the interest of both industry and Government that if States feel the need to regulate in this field, all possible efforts should be exerted to achieve a maximum degree of uniformity of standards as between the Commission and the several States.

TABLE I.—*Facility license applications*

POWER REACTORS

Applicant and location	Description of facility	Date filed	Status as of Jan. 15,1957
Commonwealth Edison Co., 72 West Adams St., Chicago, Ill. (location: Grundy County, Ill.).	180,000-kilowatt dual-cycle boiling-water power reactor.	Apr. 1, 1955	Construction permit issued, May 4, 1956.
Consolidated Edison Co., 4 Irving Pl., New York 3, N. Y. (location: Westchester County, N. Y.).	140,000-kilowatt pressurized-water power reactor (plus 96,000 kilowatts of conventional superheater capacity).	Mar. 22, 1955[1]	Do.
General Electric Co., 1 River Rd., Schenectady 5, N. Y. (location: Vallecitos Laboratory site: Alameda County, Calif.).	3,000 to 5,000-kilowatt developmental boiling-water reactor.	Jan. 10, 1956[1]	Construction permit issued May 14, 1956.
Power Reactor Development Co., 1911 First St., Detroit, Mich. (location: Lagoona Beach, Monroe County, Mich.).	100,000-kilowatt fast-breeder-type power reactor.	Jan. 7, 1956	Construction permit issued, Aug. 4, 1956.[4]
Yankee Atomic Electric Co., 441 Stuart St., Boston 16, Mass. (location: near Rowe, Mass.).	134,000-kilowatt pressurized light water-type power reactor.	July 9, 1956	Pending (application incomplete).
Aerojet-General Nucleonics, San Ramon, Calif. (for sale to a properly licensed institution).	100-milliwatt self-contained research reactor.	May 28, 1956	License issued Oct. 19, 1956.
Do	3 100-milliwatt self-contained research reactors.	Sept. 11, 1956	Pending.
Do	5 100-milliwatt self-contained research reactors.	Nov. 28, 1956	Do.
AMF Atomics, Inc., 261 Madison Ave., New York, N. Y. (location: Plainesboro Township, N. J.).	5,000-kilowatt pool-type research reactor.	Jan. 12, 1956	Notice of proposed issuance of construction permit published Dec. 29, 1956.
Armour Research Foundation, 10 West 35th St., Chicago, Ill. (location: approximately 35th and State Sts., Chicago, Ill.).	50-kilowatt water-boiler type research reactor.	Jan. 7, 1955[1]	License issued June 12, 1956.
Battelle Memorial Institute, 505 King Ave., Columbus 1, Ohio (location: West Jefferson, Ohio).	1,000-kilowatt pool-type research reactor.	May 4, 1955[1]	License issued Aug. 10, 1956.
Curtiss-Wright Corp., Clifton, N. J. (location: Quehanna, Pa.).	do	Oct. 29, 1956	Pending.
The Dow Chemical Co., Midland, Mich.	1,000 to 10,000-kilowatt liquid metal fuel-research reactor.	Jan. 31, 1956	Pending (application incomplete).
Daystrom, Inc., Elizabeth, N. J. (location: Princeton, N. J.).	Low-power research reactor.	Dec. 11, 1956	Pending.
Ford Motor Co., 3000 Schaefer Rd., Dearborn, Mich. (location: Rotunda Bldg., Dearborn, Mich.).	10- to 100-kilowatt pool-type research reactor.	Jan. 17, 1956	Pending (application incomplete).
Massachusetts Institute of Technology, 77 Massachusetts Ave., Cambridge, Mass. (location: campus, Cambridge, Mass.).	1,000-kilowatt heavy water moderated research reactor.	Feb. 20, 1956	Construction permit issued May 7, 1956.
National Advisory Committee for Aeronautics, 1512 H St. NW., Washington, D. C. (location: Sandusky, Ohio).	60-megawatt research reactor.	Aug. 20, 1956	Pending.

TABLE I.—*Facility license applications*—Continued

POWER REACTORS

Applicant and location	Description of facility	Date filed	Status as of Jan. 15,1957
Naval Research Laboratory, Washington, D. C.	100-kilowatt pool-type research reactor.	Apr. 5, 1955[1]	License issued Sept. 14, 1956.
North Carolina State College, Raleigh, N. C.	100-kilowatt water-boiler-type research reactor.	June 15, 1955[1]	License issued Oct. 1, 1955.
Pennsylvania State University, University Park, Pa.	100-kilowatt pool-type research reactor.	May 9, 1955	License issued July 8, 1955.
State College of Washington, Pullman, Wash.	....do....	June 22, 1956	Pending.
The Prosperity Co., Inc., Syracuse, N. Y. (location: University of Miami campus, Coral Gables, Fla.).	Pool-type research reactor.	Mar. 6, 1956	Pending (application incomplete).
University of California at Los Angeles, Los Angeles, Calif.	50-kilowatt water-boiler-type research reactor.	June 2, 1955[1]	Do.
University of Michigan, Ann Arbor, Mich.	1,000-kilowatt pool-type research reactor.	Jan. 12, 1955[1]	Construction permit issued Feb. 17, 1955.
U. S. Naval Postgraduate School, Monterey, Calif.	100-milliwatt self-contained research reactor (to be purchased from Aerojet-General Nucleonics, San Ramon, Calif.	Nov. 28, 1956	Pending.
Westinghouse Electric Corp., Pittsburgh, Pa. (location: Yukon, Pa.).	20,000-kilowatt test reactor (pressurized water type).	Mar. 12, 1956	Notice of proposed issuance of construction permit published Jan. 5, 1957.

[1] Date of application.
[2] Petitions for leave to intervene were granted in October 1956 and hearings were started in January 1957.

CRITICAL EXPERIMENT FACILITIES

The Babcock & Wilcox Co., 161 East 42d St., New York, N. Y. location: Lynchburg, Va.).	.....	Oct. 27, 1955	Construction permit issued Dec. 9, 1955.
Battelle Memorial Institute, 505 King Ave., Columbus, Ohio (location: West Jefferson, Ohio).	.....	Oct. 28, 1955	Construction permit issued Dec. 28, 1955.
General Atomic division of General Dynamics Corp., San Diego, Calif. (location: Terrey Pines Mesa, San Diego, Calif.).	.....	Oct. 25, 1956	Pending.
General Electric Co., 1 River Rd., Schenectady, N. Y. (location: Vallecitos Laboratory site, Alameda County, Calif.).	.....	Mar. 27, 1956	Construction permit issued June 29, 1956.
Lockheed Aircraft Corp., Missile Systems division, Van Nuys, Calif. (location: Stanford University campus, Palo Alto, Calif.).	.....	June 20, 1956	Pending.
The Glenn L. Martin Co., Baltimore, Md. (location: Middle River, Md.).	.....	Oct. 26, 1956	Do.
Nuclear Development Corporation of America, 5 New St., White Plains, N. Y. (location: Pawling, N. Y.).	.....	Mar. 14, 1956	Construction permit issued June 11, 1956.
Westinghouse Electric Corp., Pittsburgh, Pa. (location: Yukon, Pa.).	.....	Sept. 21, 1956	Pending.

TABLE I.—*Facility license applications*—Continued

EXPORT LICENSES

ACF Industries, Inc., 30 Church St., New York, N. Y.	5,000-kilowatt tank-type, heavy water cooled and moderated research reactor for export to Comitato Nazionale per le Ricerche Nucleari, Italy.	Dec. 12, 1956	Pending.
AMF Atomics, Inc., 261 Madison Ave., New York, N. Y.	10-kilowatt light-water moderated research reactor for export to Ministry of Education, Kingdom of the Netherlands, Amsterdam, Netherlands.	Sept. 27, 1956	Notice of proposed issuance of export license published Jan. 10, 1957.
Do	1,000-kilowatt pool-type research reactor for export to Laboratorium fur Technische Physik der Technischen, Hothschule Munchen, Munich, Germany.	July 2, 1956	Pending.
The Babcock & Wilcox Co., 161 East 42d St., New York, N. Y.	5,000-kilowatt pool-type light-water moderated research reactor for export to Conselho Nacional de Pesquisas do Brazil, for Comissao de Energia Atomica, University of São Paulo, São Paulo, Brazil.	Oct. 5, 1956	Notice of proposed issuance of export license published Jan. 4, 1957.
Marubeni-Iida Co. (New York), Inc., 39 Broadway, New York 6, N. Y.	50-kilowatt homogeneous solution-type research reactor for export to the Japan Atomic Energy Research Institute, Tokyo, Japan.	Sept. 13, 1956	License issued Nov. 2, 1956.

TABLE II.—*Applications for special nuclear material licenses to authorize fabrication of enriched uranium fuel elements or to process enriched uranium for ultimate fabrication into fuel elements*

Applicant	Activity	Date filed	Status as of Jan. 15, 1957
Aerojet-General Nucleonics, San Ramon, Calif.	Fabrication of core assemblies for AGN's Model 201 research reactor.	May 28, 1956	License issued July 25, 1956.
The Babcock & Wilcox Co., Lynchburg, Va.	Fabrication of fuel elements.	Aug. 18, 1955; amendments filed on Feb. 14, 1956 and July 17, 1956.	License issued Aug. 22, 1956.
General Electric Co., Metallurgical Products Department, Detroit, Mich.	Conversion of enriched uranium dioxide powder into pellets.	Sept. 20, 1956	License issued Nov. 20, 1956.
General Electric Co., Atomic Power Equipment Department, San Jose, Calif.	Fabrication of fuel elements.	Oct. 1, 1956	License issued Nov. 15, 1956.
Mallinckrodt Chemical Works, St. Louis, Mo., (location: Hematite, Mo.)	Conversion of enriched uranium hexafluoride to uranium dioxide.	May 16, 1956; amendments filed June 20, and July 12, 1956.	License issued July 18, 1956.
Metals and controls Corp., Attleboro, Mass.	Fabrication of fuel elements.	Sept. 19, 1955; amendments filed Mar. 6, 1956, July 25, 1956 and Aug. 17, 1956.	License issued Apr. 23, 1956; amended Sept. 19, 1956.
Sylvania Electric Products, Inc., Bayside, N. Y.	do	Apr. 19, 1956; amended Aug. 27, 1956 and Oct. 29, 1956.	License issued Nov. 15, 1956.
Westinghouse Electric Corp., Commercial Atomic Power Activity, Forest Hills, Pa.	do	Apr. 19, 1956	License issued Aug. 3, 1956.
Westinghouse Electric Corp., Blairsville Metals Plant, Blairsville, Pa.	do	Feb. 14, 1956; amended Feb. 20, 1956, Apr. 25, 1956 and Sept. 17, 1956.	License issued Aug. 3, 1956; amended Nov. 15, 1956.

X. United States Industry in International Atomic Cooperation

Encouragement and assistance in the growth and development of a peacetime atomic energy industry is one of the most signficant byproducts of the United States Government's program of international cooperation. While this program was conceived and is implemented as an important phase of the effort of United States foreign policy to secure world peace, the natural result of spreading the benefits of the atom abroad will be to hasten the growth of the peaceful uses of atomic energy not only in other countries throughout the world, but in the United States as well.

The atoms for peace program is designed to aid in securing the peace in two ways. First, the peaceful uses of atomic energy abroad can raise general standards of living, particularly in underdeveloped areas, and thus help to eliminate sources of unrest and tension. Beyond this lies the greater hope that the patterns of international cooperation thus established will facilitate the resolution of other great issues which today jeopardize the peace of the world.

Within these broad objectives, a practical effect of the program is to increase the pace of economic development in all countries which take advantage of the opportunities provided by atomic energy. Further, widespread utilization of the beneficent atom can be expected to produce profound changes in patterns of living and habits of consumption. Both of these developments should have a significant impact on the growth of a peacetime atomic energy industry in many countries.

Much of the ultimate success of the international program will depend upon the applications of private industrial techniques and know-how on a vigorous scale. In this respect the Government will continue to assist to the greatest extent possible in such matters as making enriched fuel available under favorable terms and conditions, assisting friendly countries in the development of atomic energy programs, providing training based on American technology and utilizing American facilities, and establishing means for rendering financial assistance. However, the industry which supplies the atomic "hardware" will obviously be a key factor in the atoms for peace program.

Developing the framework for cooperation

The initial steps in creating the basis for international cooperation were taken following President Eisenhower's historic address before the General Assembly of the United Nations on December 8, 1953. Emphasis during the program's first years necessarily centered on the establishment of a legal basis for cooperation between sovereign nations. The Congress made the basic decisions on policy and expressed them in the Atomic Energy Act of 1954 which laid the statutory foundation for the development of a program. During the past year significant progress has been made both in the expansion of the international framework for cooperation and in the development of operational phases of the program.

The number of bilateral agreements, including those for cooperation in the design and construction of power reactors, has steadily increased. Active negotiations are still in progress for more than a score of agreements either for power or research; detail is given in appendix A. On October 26, 1956, a Statute for the International Atomic Energy Agency was adopted and this new organization is expected to come into existence during 1957, linking some 80 nations in an international cooperative program and providing for an internationally administered system of safeguards over nuclear energy projects which are assisted by the Agency. In addition, important regional arrangements for international cooperation are developing in Europe and Asia. In Latin America cooperative efforts at the University of Puerto Rico and at the Inter-American Institute of Agricultural Sciences at Turrialba, Costa Rica, should have significant results. Means of coordinating these efforts with activities under the aegis of the Organization of American States are being developed. With respect to Asia, Colombo plan nations have under consideration the establishment of an Asian Nuclear Training and Research Center. Further information concerning these matters is to be found in appendix H and in the 21st semiannual report, pages 18 through 20.

Progress of the operational program

A brief review of some of the actions of the past 2 years will indicate how this program is progressing from negotiations and plans into operations.

1. Fifteen research reactors have been contracted for or are being discussed by foreign countries with American industry (see subsection A1 (b) of table Ia in section VIII).

2. Seven power reactor projects, for which American firms are providing the principal design details, are currently under consideration by cooperating nations (see subsection B7 (c) of table Ia in sec. VIII).

3. Technical missions involving over 300 United States personnel have visited foreign countries to advise them in the basic planning of their own programs and individual experts have been made available to give advise on specific projects.

4. Commitments of special nuclear material made to other nations exceed 1,700 kilograms of uranium 235.

5. Sales to other nations of heavy water totaled 70 tons in 1956.

6. Some 335 foreign students representing 50 countries have been trained in the United States in special courses operated by or sponsored by the Commission.

7. Foreign nations are participating in growing numbers as employees or guests in unclassified research in nonsecurity areas of our laboratories.

Commission actions to support program

New policy decisions on terms under which special nuclear material will be made available to the foreign program were announced by the White House and the Commission on November 18, 1956. Specific information on United States prices and policies will be useful to cooperating countries in estimating the overall economy of a power reactor complex and thus to arrange realistic financing. The new policies include establishment of a new and lower price schedule for special nuclear material, assurances of long-term fuel availability, the establishment of prices for by-product material and an offer to purchase all plutonium or uranium 233 produced in foreign reactors fueled with material obtained from the United States.

The recently announced revision of United States, Canadian, and United Kingdom declassification policies and guides will permit the United States to declassify information adequate for the design, construction, and operation of power reactors. The accelerated declassification effort will broaden exchange of power reactor information through libraries, conferences, publications, and individual industry consultations. Research reactor information was already available on an unclassified basis.

Actions to expedite industry's part in international programs

The steady growth of the international cooperation programs is the result of close cooperation between Government and industry. Government has provided the framework within which active competition for foreign markets has developed. The policies referred to above and the assistance which the Commission has provided to other nations in planning their atomic energy programs has created a favorable climate for the activity of United States industry overseas. Industry, for its part, has furthered the program by developing advanced technology, undertaking to design and test specific reactors suitable for export, providing technical services and experts for foreign programs, manufacturing equipment, fabricating materials, and, in some instances, offering to undertake the initial operation of a reactor after it is installed.

The following factors are considered to provide favorable conditions for the further growth of peacetime atomic energy industry in connection with programs of assistance to foreign countries:

1. The further declassification of power reactor technology will permit wide competition on a regular commercial basis and facilitate contacts between American firms and foreign countries.

2. The availability of special nuclear materials on favorable terms will encourage foreign countries to plan reactors using enriched fuel and thus to look to American industry with its advanced technology in this field as the principal source of equipment and services.

3. The Commission policy of supplying materials and services from its own facilities only when they are not commercially available should encourage industry to equip itself not only to design and build reactors for export, but to provide fuel cycle services on a regular commercial basis, including such services as preparing uranium compounds and metal, fabricating fuel elements, recovering cold uranium scrap, and chemical processing of irradiated fuel elements.

4. The program of financial assistance in support of research reactor projects encourages cooperating countries to seek American contractors for the design

and construction of reactors, and facilitates the purchase of required components and equipment from American industry. A similar result can be anticipated from the recent offer of the Export-Import Bank to consider loans in support of power reactor and research reactor projects.

5. By making the terms of agreements for cooperation available to the public and by keeping American industry currently informed of the interests and developments in foreign countries, commercial contacts between industry and cooperating countries are facilitated.

6. Simplification of the rules and regulations governing international trade in the atomic energy field will permit freer contact between private commercial parties.

7. As part of the Commission's general policy to rely upon industry wherever practicable, American industry has been encouraged to produce equipment and provide services in the atomic energy field, thus generally increasing its ability to participate in a competitive export trade market.

These are the general considerations involved in the program of international cooperation for peaceful uses between the United States and other nations which bear upon the growth, development and status of the American atomic energy industry as we enter 1957. Further detail on the various aspects of the atoms for peace program and its current status as it affects industry is available in eight appendices covering the following points:

A. Bilateral agreements;
B. Power reactor activities abroad;
C. Research reactor activities abroad;
D. Industry's part in supplying and servicing world atomic industry;
E. Isotopes;
F. Training;
G. Exchange of information; and
H. International organization in the nuclear field.

Appendix A. Bilateral Agreements

Since the negotiation of bilateral agreements began in early 1955, discussions have been held with 49 nations. By the end of 1956 negotiations had been completed for 43 agreements with 41 nations.

The most significant development during 1956 was the conclusion of the first power agreements with nations other than the United Kingdom, Canada, and Belgium, with which the United States always has had a special relationship in the atomic energy field. The five new agreements negotiated were with Australia, the Netherlands, Switzerland, France, and Norway. Discussions on power agreements have been undertaken with 16 additional countries.

In addition to the power reactor agreements, negotiations were concluded during 1956 for nine additional agreements for cooperation in the fields of research. New research agreements were negotiated with Austria, Costa Rica, Cuba, the Dominican Republic, Germany, Guatemala, Iran, Ireland, and New Zealand. Negotiations have been completed with Ecuador and Nicaragua. Preliminary discussions on research agreements have been held with Ceylon, Haiti, Liberia, and South Africa. In the field of nuclear power, preliminary discussions were begun with Argentina, Brazil, Cuba, Germany, India, Iran, Israel, Italy, Japan, Pakistan, Philippines, South Africa, Spain, Sweden, Thailand, Tunisia, and Uruguay. Most of these countries are reviewing draft research or power agreements.

Appendix B. Power Reactor Activities Abroad

Interest in the production of power from nuclear energy is high throughout the world. The United States is cooperating in or providing assistance to a majority of the projects which are being undertaken.

In Western Europe, power reactor projects have been undertaken or are planned by Belgium, the United Kingdom, France, Italy, Switzerland, Spain, Germany, and the Scandinavian countries. Requirements of the six nations comprising EURATOM (Belgium, France, Germany, Italy, Luxembourg, and the Netherlands), during 1963–67 for energy from nuclear power plants are expected to be in the order of 3 million kilowatts (electric) per year or 15 million kilo-

watts by 1967. Canada also has an active program. A number of these countries have expressed an interest in using nuclear power for ship propulsion.

In the Asian-African area, an increasing number of countries are expressing interest in atomic power. This interest is particularly strong in areas where hydroelectric power potential is insufficient and where the cost of transporting conventional fuel is high. Representatives of Tunisia, Turkey, Iran, Pakistan, Israel, and Ethiopia have sought information on the economics of nuclear power. Japan, which must meet increasing power needs from depleted fossil fuel reserves, has indicated that 500,000 kilowatts (electric) from nuclear plants will be required by 1965.

A few countries in Latin America are considering the initiation of nuclear-power programs, and a larger number have indicated interest in training scientists and technicians in anticipation of the future utilization of power reactors.

Negotiations relating to power agreements are underway with four Latin American countries. An American company has announced plans for the installation of power reactors in Brazil, Cuba, and Mexico. United States manufacturers of the reactors have been selected.

Export-Import Bank financing

In October 1956, the Commission and the Export-Import Bank agreed on joint action under which the bank would consider extending credit for the construction of nuclear powerplants (as well as research reactors) in nations which enter into agreements for cooperation with the United States.

The bank will consider loans to both governments and industries. The AEC will provide technical assistance in connection with the bank's study of loan applications. In order to qualify for bank assistance, a cooperating country must submit a comprehensive engineering survey of the project. The country requesting a loan must have an arrangement for securing atomic fuels for the term of the loan and must demonstrate evidence of the economic and financial soundness of the project, the availability of funds to defray local costs, and the ability to serve the dollar debt involved. As is the case with Export-Import Bank loans for other purposes, the loans for nuclear-power projects may be spent only for equipment, materials, and technical services purchased in the United States.

United States development of additional types of power reactors suitable for export

A portion of the Commission's civilian power-reactor program is directly applicable to the needs of foreign countries, principally through emphasizing development of reactors in smaller size ranges and establishing programs for development of fuel cycles permitting the use of natural uranium.

The emphasis on smaller reactors conforms with the estimated needs of a majority of the foreign countries. A recent study of possible world demand for power reactors by 1960 indicated about 45 percent of the possible demand to be for plants of 10,000 kilowatts or less, 29 percent for plants of about 25,000 kilowatts, 17 percent for plants of about 50,000 kilowatts, and 9 percent for plants of 100,000 kilowatts or over.

The programs for development of fuel cycles using only natural uranium are in line with the natural desires of other nations and the United States to have available as wide a choice of reactor fuel as possible. The portion of the Commission's experimental power-reactor program which is applicable includes a project undertaken by General Electric Co. at Hanford aimed at demonstrating the feasibility of recycling plutonium in thermal reactors and a concentrated study on heavy water-natural uranium reactors, including work by E. I. du Pont de Nemours Co., at the Savannah River plant. Moreover, in the third invitation for proposals under the power demonstration reactor program, the Commission indicated it would be particularly receptive to proposals for natural uranium fueled, heavy water-moderated reactors.

Appendix C. Research Reactor Activities Abroad

During 1956 procedures were established and anounced for implementing the President's offer of June 11, 1955, to contribute toward the cost of research reactors undertaken by "free nations who can use them effectively for the acquisition of the skills and understanding essential to peaceful atomic progress." Contributions made pursuant to the President's offer are financed from funds

made available under the mutual-security program. Only nations which have entered into agreements for cooperation with the United States are eligible to receive assistance under the President's offer.

The amount of the contribution to each nation is limited to $350,000, or one-half the total estimated cost of the reactor project, whichever is less. The amount of the grant is set with respect to a complete reactor project, including reactor and such experimenal equipment and supporting facilities and activities as are necessary to make it an operable and useful training and research tool.

Grants of $350,000 each have been approved for projects in Brazil, Spain, Denmark, and the Netherlands.

Requests for grants have also been received from Belgium, Greece, Israel, Japan, and West Germany. In each of these cases, however, the project proposal data are not as yet complete.

Appendix D. United States Industry's Part in Supplying and Servicing World Atomic Industries

Industrial firms assisting other countries are required by section 57 a (3) of the Atomic Energy Act of 1954 to receive an authorization from the Commission. Prior to October 1955, industrial firms required specific authorization from the Commission to furnish services and materials to foreign nations even on an unclassified basis. As the program of declassification advanced and the amount of unclassified information increased, the Commission announced a general authorization for unclassified activities abroad on the part of industrial firms. This general authorization will increase in importance as, in accordance with present policy, power reactor technology is declassified. American industry under the general authorization has embarked on an active commercial program.

During 1956, the classified authorization program completed its first year. In this period 18 authorizations were granted for activities in the three countries with which the United States has effective agreements permitting the exchange of classified information; 13 under the Canadian agreement, 3 under the Belgian agreement, and 2 under the agreement with the United Kingdom.

The authorizations are as follows:

United States firms and scope of approved exchange

AUTHORIZATIONS UNDER THE AGREEMENT WITH CANADA

General Electric Co.	Thermal reactor powerplant.
Catalytic Construction Co.	Do.
Do.	Production and fabrication of uranium metal.
Nuclear Metals, Inc.	Technology of fuel element production.
Metals and Controls Corp.	Do.
Rohm & Haas Co.	Processing and refining of ores.
Westinghouse Electric Corp.	High temperature and high pressure irradiation facilities.
General Dynamics Corp.	Manufacture of a swing reactor.
AMF Atomics, Inc.	Design, development and fabrication of fuel elements.
Sylvania Electric Products Co.	Do.
Koppers Co., Inc.	Processing of source materials, recovery facilities
Norton Co., Inc.	Technology of fabricating control rods, crucibles and fuel elements.
Giffels & Vallet, Inc.	Technology of processing and fuel fabrication.

AUTHORIZATION UNDER THE AGREEMENT WITH THE UNITED KINGDOM

The Lummus Co.	Engineering and design services for evaluation of power reactors.
AMF Atomics, Inc.	Engineering and design services for evaluation of AMF boiling water reactor.

AUTHORIZATIONS UNDER THE AGREEMENT WITH BELGIUM

Westinghouse Electric Corp.	Manufacture of Belgian thermal reactor.
Nuclear Development Corp. of America	Design of MTR type reactor.
Atomic Power Development Associates	Development of Belgian fast breeder reactor.

Seven American firms have undertaken or are discussing contracts to design and construct 13 research reactors in 10 countries. (See subsection A1 (b) of table Ia in section VIII.)

Four American firms are providing technical advice to six countries in the advance planning of power reactors which may result in contracts for their design and construction in the near future. (See subsection B7 (c) of table Ia in section VIII.)

Many American firms are also equipped to export equipment, instruments, and other items for use in national atomic energy programs, including such items as isotopes and heavy water.

Industrial participation in the international program has been assisted by the policy that services and materials will be furnished by the Commission only when such services or materials are not available commercially. Thus, the only activity from which industry is excluded is the supplying of nuclear material. As has already been discussed in section VI, the Commission is encouraging industry to undertake the preparation of uranium compounds and metal and to undertake the recovery of cold uranium scrap; when established, these services can be made available to foreign as well as domestic customers. In general, it is expected that fuel for reactors will be released in the form of uranium hexafluoride to United States contractors selected by the cooperating nations which will process and fabricate it into fuel elements under the terms of the civilian licensing program prior to export overseas as required by law.

Spent fuel from foreign research reactors fueled with United States material must be returned unaltered to the Commission or may be reprocessed in facilities acceptable to the Commission. This requirement anticipates the establishment of reprocessing facilities by industry, as well as future international arrangements to provide this service.

As previously stated, research reactor grants are made on the basis of a review of a comprehensive project and design proposal, prepared usually with the detailed assistance from a contractor selected by the country concerned. While it is not required that the contract be with an American firm, this has been the case in the four grants made.

In addition, all component parts of reactors and related equipment will be fabricated and sold by industrial firms through normal commercial channels. In some instances, industry will undertake the initial operation of the reactor.

Appendix E. Isotopes

Isotopes have been available both from the Commission and from industry for use abroad for some years. On February 10, 1956, procedures for exporting isotopes were simplified. It is no longer necessary to have prior Commission approval for the export to friendly nations of byproduct material with atomic numbers 3 through 83. Moreover, a license from the AEC is no longer required for the export of cyclotron-produced radioisotopes.

As a result of these new simplified export procedures, isotopes (both radioactive and stable) are now available on a routine basis to foreign nations from AEC National Laboratories and from over 75 commercial firms in the United States. The new export procedures also make electromagnetically separated and enriched stable isotopes available for procurement by foreign scientists at the same prices as are charged United States citizens.

The two atoms-for-peace missions, which recently visited countries in Latin America, included specialists in agriculture, medicine, biology, and industry who provided information on the application of radioisotopes to these fields in Latin America. The countries visited were Venezuela, Brazil, Uruguay, Argentina, Chile, Peru, Ecuador, Panama, and Costa Rica. In all of the countries great interest and enthusiasm was shown.

Appendix F. Training

A major obstacle to the rapid development of national atomic-energy programs abroad is the lack of personnel trained in nuclear technology, and, in many cases in the basic scientific disciplines. The ability of nations participating in the atoms-for-peace program to train personnel, in adequate numbers and in reasonable time, is the exception rather than the rule. Training programs, therefore, have a high priority. Four major steps are underway to meet this need: The admission of more foreign nationals to the isotopes courses at the Oak Ridge Institute of Nuclear Studies, the expansion of the program of cooperation between American universities and the International School of Nuclear Science and Engineering of Argonne National Laboratory, the planned Spanish-language training center at the University of Puerto Rico, and the planned Asian Nuclear Center in the Philippines.

The principal purpose of the United States training programs is to equip personnel to operate effective programs in foreign nations. An important byproduct of these programs is the increasing acceptance of American technology.

During 1956, a total of 42 foreign scientists was admitted to the radioisotopes tracer techniques courses at ORINS. A maximum of 32 individuals can be accommodated in each of the 4-week courses which provide training in the fundamentals of handling and using radioisotopes in research.

Appendix G. Exchange of Information

During 1955 a large volume of the technical information on peaceful uses of atomic energy was declassified and made available at the International Scientific Conference in Geneva. In December 1956, the Commission announced a large scale program of declassification, particularly in the field of power reactor technology.

Two important effects of this further declassification of technical information will be to broaden considerably the interest and activity of friendly nations in pursuing the potentialities of civil uses of nuclear energy and to encourage private industry to satisfy the needs of foreign nations for reactors, reactor equipment, and fuels.

Extensive information, both of a classified and an unclassified nature, has been made available through the exchange of reports, documents, publications, libraries, exchange of visits, technical missions, and formal conferences.

The distribution of technical libraries to foreign countries has demonstrated United States willingness to make a wide range of unclassified information available as quickly as possible. Workshops on the use of the libraries are being planned so that recipient nations may learn to use them most effectively.

There have been numerous exchanges of visits of a classified nature between the United States and Belgium, Canada, and the United Kingdom. (Details on these exchanges may be found in the 21st semiannual report, pp. 16–18.)

In addition to the classified meetings, technical missions involving over 300 United States personnel have visited 58 countries. Matters discussed by these missions included overall planning of national programs, economics of nuclear power, selection of power reactor types, research reactors, and their uses in training and research programs and applications of atomoc energy products to agriculture, medicine, and industry. Details on these missions may be found in the 21st semiannual report, pp. 16–17.)

Conferences and exhibits

Participation in and support for international scientific conferences on the part of the Commission serves to accelerate the growth of the atomic energy industry by furthering exchange of information and quickening interest in atomic energy, both in this country and abroad. Through the atomic energy exhibits, which industrial firms make available for display at such conferences as well as at the international trade fairs and exhibitions, American industry makes a most significant contribution to international cooperation in developing peaceful uses of the atom.

For the past several months the Commission has been engaged in planning for United States participation in a major international conference, a world's fair, and an educational symposium. These are the second International Scientific Conference on the Peaceful Uses of Atomic Energy, the Brussels Universal and

International Exhibition of 1958, and the Inter-American Symposium which is the first of its kind in the Western Hemisphere.

The Second International Scientific Conference on the Peaceful Uses of Atomic Energy will be held for 2 weeks beginning about September 1, 1958, in fulfillment of a resolution sponsored by the United States and adopted unanimously by the United Nations in December 1955. The Commission has accepted responsibility for planning and coordinating the United States technical participation in the conference. The conference will cover all phases of the peaceful uses of atomic energy of interest to the participants, but will emphasize nuclear power. The location of the conference has not yet been determined.

It is contemplated that a United States exhibit will consist of a group of individual displays, each arranged and prepared by an atomic laboratory, industrial concern, or other organization, with overall planning and coordination by the AEC.

The Brussels exhibition is scheduled to open in mid-April 1958 and to run until October 1958 with the theme "A world built by and for the people."

The Inter-American Symposium is expected to take place at the Brookhaven National Laboratory, Long Island, N. Y., in May 1957.

Appendix H. International Organizations in Nuclear Field

International organizations are being developed to establish the framework within which cooperative efforts can be undertaken. On a regional basis they serve to make possible at an early date cooperative or joint projects now beyond the reach of individual countries. Such organizations are most fully developed among the industrialized countries of Europe in the form of the Organization for European Economic Cooperation (OEEC) and the proposed EURATOM. The International Atomic Energy Agency, which will come into existence in 1957, will link together some 80 nations. It will not only make possible cooperative programs but will make available assistance to countries which prefer to participate in multilateral rather than bilateral efforts.

International Atomic Energy Agency

The Agency will come into existence when the statute, adopted last October at an 82-nation conference, is ratified by 18 states. This probably will be accomplished in the summer of 1957. The matter of United States ratification will come before the Senate at this session of Congress. While time will be required to work out arrangements enabling the Agency to furnish fissionable materials for use in reactors abroad, ultimately the operations of the Agency should increase the number of countries taking advantage of opportunties for peaceful utilization of atomic energy. *It is expected that many states will prefer to secure assist*ance from an international agency, in which they enjoy membership, and will prefer an internationally administered system of safeguards.

The agency itself will furnish technical information and fissionable and other materials not commercially available. It is contemplated that *all other equip*ment and materials, such as reactor components and related equipment, will be *supplied through normal commercial channels.* Such a policy would expand the market for products essential to nuclear energy enterprise of all types and draw upon any business community equipped to supply the required goods and services.

EURATOM

Representatives of Belgium, France, Germany, Italy, Luxembourg, and the Netherlands are presently drafting a treaty setting up a European organization for atomic-energy cooperation similar to the Coal and Steel Community. The basic activities, as now contemplated, will be creation of a research center to supplement expanding private and national facilities, act as a clearinghouse for information, proposal of security forms and controls over nuclear materials for use in the community, assist in placement of capital investment, and initiation of construction of common installations. The treaty drafting will probably be completed early in 1957.

Organization for European Economic Cooperation

During the past few months, working groups of the OEEC engaged in nuclear studies have developed specific plans of action. The most advanced of these working-group studies deals with the construction of a chemical reprocessing facility. Another working group has been established to study experimental

reactors and materials testing reactors. This group is interested specifically in developing ideas on the joint construction and operation of a high flux materials testing reactor and in further study of advanced types of power reactors which might be constructed and operated experimentally as a joint or coordinated effort. The United States has been asked to participate in this working group, since most of the reactors of interest have been developed in the United States. Consideration is being given to providing United States expert assistance to this study.

Organization of American States

The Inter-American Committee of Presidential Representatives of the OAS has before it for consideration early this year a United States proposal for the establishment of an OAS Consultative Committee on Nuclear Energy. The Committee would function in a consultative capacity as an instrument for the stimulation, coordination, and support of national atomic-energy efforts and their orientation to serve the needs of the Inter-American Community. Means to coordinate Commission activities with the efforts of this committee are being developed.

(Whereupon at 4:40 p. m., Tuesday, February 19, 1957, a recess was taken until Wednesday, February 20, 1957, at 10 a. m.)

DEVELOPMENT, GROWTH, AND STATE OF THE ATOMIC ENERGY INDUSTRY

WEDNESDAY, FEBRUARY 20, 1957

CONGRESS OF THE UNITED STATES,
JOINT COMMITTEE ON ATOMIC ENERGY,
Washington, D. C.

The committee met at 10 a. m. pursuant to notice, in the old Supreme Court Chamber of the Capitol, Hon. Carl T. Durham (chairman of the Joint Committee) presiding.

Present: Representatives Durham (presiding), Holifield, Price, Cole, Van Zandt, Patterson, Jenkins; and Senators Pastore, Gore, Bricker, and Dworshak.

Also present: James T. Ramey, executive director; George E. Brown, Jr., David R. Toll, professional members of the staff; and George Norris, Jr., committee counsel.

The CHAIRMAN. The Joint Committee will come to order.

We are glad to have with us this morning a group of business people from throughout the United States. We will probably not have as many members present today as we had yesterday, when we had nearly all of the members present. We also have a controversial measure on the floor of the House this morning.

We are glad to have with us this morning our former Secretary of the Navy, Mr. Dan Kimball, as our first witness.

Will you come around, please, Mr. Kimball? We welcome you back to Capitol Hill. We have seen you many times before in the Armed Services Committee on different matters, and we are glad to see that you have now gone into this business and we hope you will have much success in the future.

Will you proceed with your statement, Mr. Kimball, and we will probably have some questions later.

STATEMENTS OF DAN A. KIMBALL, PRESIDENT OF AEROJET-GENERAL CORP.; AND ARTHUR T. BIEHL, TECHNICAL DIRECTOR OF AEROJET-GENERAL CORP.

Mr. KIMBALL. We are very happy to be here today and we want to thank you for your courtesy and the opportunity to give you a little résumé of Aerojet-General's activities in the field of atomic energy. I would like to outline for you some of the reasons why we are in this field and indicate some of the progressive results we have achieved.

Before going into detail, however, I would like to touch briefly on (*a*) what Aerojet-General Corp. is, (*b*) our major objectives, (*c*) what

we have already done in the area of atomic energy, and (*d*) some of the problems we face.

Many of you are probably familiar with the fact that Aerojet-General Corp. is a subsidiary to the General Tire & Rubber Co., of Akron, Ohio, and that Aerojet-General's primary interest is in the field of rocket propulsion engines.

The company originated as a relatively small group of scientists at the California Institute of Technology, which during the war developed and produced the now famous JATO unit for assisting aircraft in takeoff or augmenting thrust in flight in emergency conditions. We have produced more than 500,000 of these units and they continue to be used successfully by the military services.

Since the war we have grown from approximately 300 employees to nearly 10,000 and our major facilities are at Azusa, Calif., near Los Angeles, and at a 20,000-acre site near Sacramento, Calif. Our nucleonics activities are in San Ramon, Calif., outside of Oakland.

During the last few years we have been engaged in developing and producing components for nearly all our missile programs. Today, among our major projects are the development of a propulsion system for the ICBM and the second-stage propulsion system for project Vanguard, the earth satellite, as well as propulsion systems for the Polaris, which is the IRBM.

During this period, because of our alert and extensive research facilities, particularly in the physical and chemical fields, we have extended our operations into areas bordering upon the atomic-energy programs through construction of pumps and other auxiliary equipment for the Atomic Energy Commission and Atomic Energy Commission prime contractors.

More recently we established an atomic-energy department at our Azusa headquarters and we began a concerted effort to bring our engineering talents and production capabilities directly into the field of nucleonics. As part of this progressive entry into the nuclear-energy field, we established a subsidiary, known as Aerojet-General Nucleonics, at San Ramon, Calif. Dr. Biehl, who is here with me, is the head of this organization.

Our entry into the nuclear field is entirely consistent with our long-established policy of designing and developing as well as producing, advanced power sources. We consider nuclear reactors to fall within this category of advanced power sources and we believe that Aerojet-General will have a major part in the development of nuclear reactors for power and propulsion in the future. I don't mean to imply that Aerojet anticipates becoming a major central-station powerplant producer. Our intention was rather to participate in the production of small nuclear reactors to be used for research, as auxiliary power or propulsion units or for specialized purposes that fall generally outside the field of large turbine and generator manufacturers and utility companies.

So as to implement our entry into this somewhat competitive field of specialized advanced power sources we considered it was necessary to develop and produce a complete reactor system rather than only produce and develop reactor component parts. This policy resulted in our developing and producing the very small AGN 201 nuclear reactor as a first step. I think that some of our experiences in this first step into the nuclear reactor system field may be of special interest to this

committee since we achieved what might be termed a number of "firsts."

For example, our AGN 201 reactor is the first commercial reactor to be produced and operated by a profit-motivated company on private capital.

Also, the AGN 201 reactor is the first reactor to be produced in what we term "mass production," that is at a current rate of 1 per month and in the very near future at the rate of 2 per month.

Also, the AGN 201 reactor is the first, to our knowledge, completely new reactor concept (that is, non-AEC designed) to be produced and operated in the United States by a commercial firm.

We are proud to say that this reactor was conceived, designed, built, placed in operation, and is now in production with all financing accomplished through private-venture capital. I am also informed that technically there are a number of other first that some of our engineers and scientists are very proud of.

For example, I am told that the AGN 201 reactor is currently operating on the lowest critical mass of U–235 of any reactor in the country; that it is the smallest physical size of any reactor to be developed; and, that it is the first reactor to be built which is so safe that so far no one has doubted the feasibility of placing this reactor in schools, hospitals, industrial sites, or in any other heavily inhabited areas.

I would like to take a few minutes to describe some uses and characteristics of our little reactor.

The AGN 201 has three primary uses:

(1) In the educational field for the training of nuclear engineers;

(2) In the medical field as an "isotope refrigerator" for the production of on-site isotopes; and

(3) In industrial process control.

Relative to its educational purposes, I am sure most of you are familiar with the fact that one of the gravest problems facing the nuclear industry today is the availability of trained nuclear engineers. American universities have exemplified their readiness and ability to take on their traditional task of educating engineers for American industry by the current attitude of some 25 universities which have established coordinated programs to fulfill this pressing need. Many of these universities also have applied to the AEC under the AEC grant program for AGN 201 nuclear reactors as well as other training aids. A training reactor as part of this educational program is now generally considered essential. The principal characteristics such a reactor must have for training purposes are—

(*a*) it must be located on the campus;

(*b*) it must be safe in all respects for students, who after all, may be considered the most dangerous type of person to have around a nuclear reactor; and

(*c*) it must be of sufficiently low initial cost and maintenance cost to allow wide dissemination to most universities.

The AGN 201 nuclear reactor was basically designed to fulfill these requirements and its use in other fields such as medicine and industrial process control is what might be considered a dividend, or another use, rather than its primary purpose. I have been told by the AEC that some 26 schools have applied for AGN 201 nuclear reactors.

The usefulness of this reactor in educational programs has been proof-tested through both commercial-educational courses for industry conducted at Aerojet-General Nucleonics at San Ramon on a monthly basis as well as by the use of the reactor by non-United States citizens studying nuclear engineering at the University of California. These foreign students were unable to obtain access to any other reactor in the country and were allowed to complete this necessary part of their education on the Aerojet reactor in San Ramon.

For medical purposes the AGN 201 reactor may be considered as an "isotope refrigerator," that is, the reactor can be placed in an existing room in an existing hospital, close to the point of ultimate use of the isotope, and isotopes may be taken from the reactor as needed, just as drugs are taken from a refrigerator. Under this aspect, the isotopes of primary interest are those having a very short half-life, that is of somewhat less than a day. These isotopes are not usually available through normal AEC channels (via Oak Ridge) since they would decay and fade away before shipment could be made to remote locations for ultimate use. As an example of this type of use, the Bethesda Naval Medical Center will soon have one of our reactors in operation for the production of these short-lived isotopes. The medical officers there expect to treat literally thousands of persons per year and to diagnose diseases and malfunctions of the body that would not be possible without this small reactor. If I may take the liberty of prognosticating on the future of low power reactors for hospitals, I would say that we will all see the day, in not too many years, when small nuclear reactors will be as common in hospitals as X-ray machines are today. The Bethesda reactor will be able to supply isotopes to other hospitals in this area.

The use of nuclear reactors in industrial process control is just beginning to be considered by major American industries. Of course, reactors have been used for this type of analysis in the atomic energy laboratories for years—ever since the last war. This use may be considered as analogous to the use of a mass spectograph or electron microscope; that is, that by placing samples to be analyzed in the reactor one can determine the compositional impurities down to parts per million in many cases, depending upon the nature of the impurities and the material of the sample. This application includes the determination of alloy constituents of metals, determination of the enrichment of various ores including uranium, and many other metallurgical petro-chemical analyses.

The principal advantage over other methods is the rapidity and the nondestructive nature of the analyses. As an example of the use, consider an aluminum allow of physical size perhaps one-half inch in diameter by 2 inches long. For example, by placing this in the reactor one can determine in less than a minute the copper content, which may only be a few percent, down to an accuracy of approximately one part per hundred.

The AGN 201 nuclear reactor can best be described by considering this model before me. We have this model here. This reactor itself consists of a steel tank some 6½ feet in diameter by 9 feet high. Inside the tank there is water except for the inner part which consists of lead and graphite surrounding the reactor core. The core is made of a homogeneous mixture of uranium oxide and polyethylene about

10 inches in diameter by 10 inches high. The core contains some 656 grams (approximately 1½ pounds) of U–235 in the form of 20 percent enriched material. As mentioned previously, this is less U–235 than any other operating reactor currently in use.

The reactor is controlled from the desk-size console by moving the control and safety rods projecting from the bottom of the reactor. The power is measured by ion chambers and counters connected to appropriate instruments located in the console.

For educational purposes we believe there is no fundamental reason why the reactor should be operated at powers higher than one-tenth watt as this is sufficient to perform all educational experiments and yet is sufficiently low to prevent dangerous quantities of radioactivity to endanger the health and safety of the students.

Yet, the reactor is so constructed that if, for instance, one wishes to produce, for medical or industrial purposes, larger quantities of isotopes, the power may be increased to 5 watts. Tests have indicated at these powers that the core and reactor itself will last for scores of years effectively. The complete reactor delivered, installed, and licensed, together with appropriate training courses for the user sells for $95,000, a sufficiently low price to make it available on a wide basis.

No special buildings or facilities are needed, other than 110-volt alternating current for operation of the reactor. Experience has indicated that the upkeep is very low, and that the operation of the reactor requires only one person on a part-time basis. Lease and lease-option plans exist as well as trade-in plans if larger reactors are desired at some future time.

The current status of our "mass production" is that we have several reactors completed with a total of nine in various degrees of completion. We have recently started on the next group of 12, which will bring the total number in production to 21.

In such a new type development in the atomic-energy program, it would not be fair to say we have not had any problems in bringing the reactors to a production-line basis. We sincerely thank the Atomic Energy Commission for their extreme cooperation in such a new venture. We have presented them with special problems such as multiple licensing, procurement of special nuclear materials, transfer of facilities licenses, and mass production assembly-line-type construction.

We must remember that reactors of this type had never been built before and no reactor had ever been built in such quantity before. In these circumstances, the AEC had to rapidly develop new concepts and methods of handling the multitude of problems presented. You are all familiar with the fact that it takes just as much licensing and that the regulatory standards are the same for a very small reactor of this type as they are for even the largest reactors. Assisted by what might be termed "performance above and beyond the call of duty" by the AEC, particularly in the Division of Licensing and the Division of Civilian Applications, we have managed to adhere very closely to our original schedules of making this reactor available in quantity to the educational, medical, and industrial uses I have described.

This, in brief, is the story of Aerojet's participation to date in the atomic-energy field, and its prospects for future development of

small reactors to meet training needs and requirements in other fields.

If there are any questions, I would be happy to answer them, or to elaborate in any way I can upon this statement.

Thank you very much.

The CHAIRMAN. Thank you very much, Mr. Kimball. It looks like you have built and completed a very useful tool. According to your statement you can do just about everything with it that can be done with a very large-type reactor.

I was a little bit surprised that you could do metallurgical work with it. You can carry out all of the experiments on metallurgical work with this size reactor.

Dr. BIEHL. I do not think it says so here, and I do not think that was meant to be implied. That is general metallurgical work. You can use it for an analysis of alloys. However, you cannot use it for many other phases of metallurgical work such as radiation damage to fuel elements.

The CHAIRMAN. How large a piece of metal could you place in this reactor?

Dr. BIEHL. Typically for analysis, the sample might be a half inch to three quarters of an inch in diameter, by two inches long, or perhaps the size of a pencil or thereabouts.

The CHAIRMAN. Has it passed all safety tests?

Dr. BIEHL. Yes, it has.

The CHAIRMAN. And it has been approved, of course?

Dr. BIEHL. Yes, it is operating right now.

Mr. KIMBALL. It has been operating for several months.

Dr. BIEHL. About 4 months.

Senator PASTORE. I am intrigued by this presentation. How big a machine is this? What is the size?

Dr. BIEHL. 6½ feet in diameter by 9 feet high. It weighs, with the water shielding inside the tank, about 22,000 pounds, and wtihout the water shielding, some 15,000 pounds. That is water and all. There are some 7,000 pounds of water in the tank.

For shipment you drain the water and then fill it up wtih a garden hose.

Representative PATTERSON. 8hat is installed for $95,000?

Dr. BIEHL. That is right, installed with all services, including shipping and training and everything else that a person must have in order to have the reactor.

Representative PATTERSON. You stated that there would be a turn-in. Suppose a person were buying another reactor? How would you handle that? That would be the same basis as turning in an automobile, and being given an allowance?

Dr. BIEHL. Just the same as a trade-in on an automobile. I am not sure exactly what the reimbursement would be, but we would take it back and recondition it and give it to a new customer.

We have not established a trade-in value on them but we can see particularly in some hospitals, and some industrial process controls, they may want a little higher power reactor after a year or so, and we can transfer this to other places where they need a smaller one.

Senator PASTORE. How many of these are in use now?

Mr. KIMBALL. We have the first one in operation and the next three are expected to go into operation within the next 30 days.

Senater PASTORE. You are going to install one in Bethesda.

Mr. KIMBALL. We are going to put one in Bethesda, and we have a number of the universities that have applied for them under this AEC grant program. We are putting one in Philadelphia, up at the Atomic Exposition in the middle of March.

Senator PASTORE. What is this about not requiring anything other than 110-volt a. c. current for operation? Will you explain that to me?

Dr. BIEHL. There is no heat required, and there is no water required. We could operate it in this room if nobody objected.

Senator PASTORE. You plug it in like a television set.

Dr. BIEHL. Like a toaster, or anything else.

The CHAIRMAN. You do not even have to have special wiring?

Dr. BIEHL. There is no special wiring.

Senator PASTORE. And you have been successful with it up to now?

Dr. BIEHL. It is operating fine and we would like to invite you out to operate it if you would like to.

Senator PASTORE. We would like to see it.

Mr. KIMBALL. We would like to invite you up to the Atomic Exposition, because this is the first time a reactor has been operated publicly, and it is perfectly safe, so you can operate it in any building or any room.

Senator PASTORE. I was there in the month of December, and I am sorry no one told me about it. I could have gone over very easily to see it.

Representative PATTERSON. How is the insurance on this? Is there a policy worked out on this particular reactor while in operation?

Mr. KIMBALL. We do not think you require any special insurance on it. We have a blanket coverage from our insurance people but we do not think that there is any danger in it under any circumstances.

Representative PATTERSON. Therefore the insurance problem is licked as far as this reactor is concerned.

Mr. KIMBALL. Yes. What we want is something that you can put in any university and any building, so that you would have a reactor available for teaching. We have had dozens of the students from the University of California come over and run experiments on it.

Representative HOLIFIELD. Mr. Kimball, of course, I have known about this for some time, because you were kind enough to send me a complete set of drawings on this and pictures of it and so forth. I want to say as a fellow Californian that I am proud that your company, being a California concern, has gone ahead and perfected this very reasonably priced device, and very useful device.

With the anticipation of the building of a lot of these small research-type reactors for use in making isotopes and medical work, we placed in the Atomic Energy authorization for appropriation the sum of $5 million to participate in grants in foreign countries.

It was our thought that from a good will standpoint, and from a standpoint of advertising, you might say, the atoms-for-peace program, if we had a great many reactors of a small type like this which would be used in universities and hospitals throughout the world, we would get a tremendous amount of good will as a result of it.

Now, I confess that most of us thought that it would be around $350,000 or $300,000 to produce a reactor, and the fact that you have

produced one for around $95,000 I think is a very great compliment to your company. I want to join in congratulating you on producing this fine and usable reactor.

Mr. KIMBALL. We have had a great number of inquiries from foreign countries which we have answered, and we are in the process of negotiating with them. We cannot send them a reactor until they have someone licensed to run it, and so it is going to be necessary for them to send someone to San Ramon to be trained and to be a licensed operator.

Representative HOLIFIELD. That is true. Of course, a great many of these international agreements for the exchange of atomic information, and so forth, depends upon the building up in those countries of people that are capable of operating the reactors, and using radiated substances, and so forth. But as this training program is enlarged, and particularly where you have such a simple machine as you have here, and apparently a foolproof type of machine, it would seem like this field would enlarge very quickly.

Mr. KIMBALL. We ran a survey on this, and we think you are going to have to train about 35,000 nuclear engineers in the next 10 years. We think there is a possible market for several hundred of these, at least, just in the teaching field, and that is in addition to medical field and the process control.

Now, we did not realize the advantages we could get out of process control. There have been a number of oil companies out there, and they can do many things with a reactor of this type or slightly higher powered that it would take a long time to do in the laboratories.

Representative HOLIFIELD. I was going to ask you if it would be possible to enlarge this or build one 3 or 4 times as strong as this, or as powerful as this reactor, by just increasing your design.

Mr. KIMBALL. We have a more powerful one of this type, and then one up to about 10 kilowatts. But we want to get some of these sold, to get some of our money back before we start going into the other ones. But we have plans for building larger ones.

Senator PASTORE. Are you the first in this field, as far as you know?

Mr. KIMBALL. As far as we know, yes.

Senator PASTORE. How about other countries?

Mr. KIMBALL. I cannot speak what is in other countries.

Senator PASTORE. You say you could get down to producing two a month.

Dr. BIEHL. We are producing one a month now, and we are going on to two a month soon.

Representative COLE. When you speak of mass production, that means that you are going to make these even though you do not have orders for them?

Mr. KIMBALL. We are not going to go too far ahead of what we can foresee in the way of orders. It is pretty hard for us to anticipate now what the sale is going to be for them.

Representative COLE. You wait until you get the order before you start making one?

Mr. KIMBALL. Oh, no.

Representative COLE. There is no great delay for a purchaser to have the thing delivered and installed.

Mr. KIMBALL. We made the first one before we ever knew we could get an order, and we started on the second three before we knew we had any orders.

Representative COLE. That is understandable at the beginning you would do that.

Mr. KIMBALL. We have orders for six beyond that.

Representative COLE. I was curious about your statement that this is the only reactor that certain foreign students were allowed to visit and inspect in this country. Why is that?

Mr. KIMBALL. I do not know about that.

Representative COLE. Was that because of their status, or what was the reason?

Dr. BIEHL. These foreign students were from the University of California studying nuclear engineering. The students, the normal United States students, have been using the reactor at the University of California Radiation Laboratory, but this is not possible for foreign students. Accordingly, they use the Aerojet reactor. There may have been other reactors in the country that they could go to, but——

Representative COLE. You mean students from abroad who are attending the University of California are not allowed to visit the reactor at the university?

Dr. BIEHL. That is right, at the University of California Radiation Laboratory, which is an AEC laboratory.

The CHAIRMAN. Foreign students are permitted to visit the reactor at the University of North Carolina, in Raleigh, and they are also permitted to visit the one in Brookhaven.

Representative HOLIFIELD. I think that you are talking about different things, though. The Radiation Laboratory at Berkeley is of course an AEC operated one, and operated under contract, and it is engaged in a great many highly secret projects. To go into the area there where the reactor is, I think would be a matter of security.

Representative COLE. That does not explain why American students attending that same university are allowed to go into this Berkeley reactor, but students from abroad in the same university are not allowed.

Mr. KIMBALL. This is a little more convenient for them. We keep this open nights and weekends so that the students can come over there and work on weekends. Almost every weekend there are a number of them working on it and running experiments.

Representative COLE. I have only one other question. This is a very intriguing and interesting device that you have developed, but one of the principal purposes of this hearing or these hearings, is not only to learn what has developed in the art as your presentation indicates, but also to learn the operation of the law in this field.

Do you have any suggestions to make with respect to Commission regulations or Commission rules, or provisions of the law? Are they limiting in any degree, and do you have any recommendations about that?

Mr. KIMBALL. We have proposed some rather perplexing problems to the AEC, because we have to go to the same amount of paperwork to get a license on this as you do on the biggest reactor.

Now, obviously, that will straighten itself out as time goes along, and the AEC has been very cooperative with us in working with us. They have certain regulations laid down on the licensing of these, that may not apply to the same extent to a small reactor as they would to a large one. All of the safety regulations, and where you are going to install them before we can move this reactor from where we built it to where we want to use it, we have to have permission to do that. That is set down by statute and so there is nothing that you can change.

Representative COLE. That may be annoying, but does it bother you very much to have to go to the Commission and tell them where you are selling this, and where it is going to be used?

Mr. KIMBALL. It involves a lot of paperwork. There is nothing we can do about it now, and we understand that, and it has worked all right. As we make these things by the dozens, we think probably the AEC will want to simplify their work as they get into it.

Representative COLE. If experience shows that the Commission can modify its regulations to facilitate the distribution and use of these reactors, you do not have any reason to believe that the Commission would not do it, do you?

Mr. KIMBALL. No, they have worked with us very closely on it, and they have been very cooperative.

Representative COLE. Is your company engaged in any other aspect of the atomic program than the manufacture of this particular reactor?

Mr. KIMBALL. No, we have some other work. The AEC a few months ago awarded us the job of building or designing and building a gas-cooled reactor. Part of that work would be done at San Ramon, and part would be done in Azusa. We have that contract, and we have some other work that we are doing. We do not propose to do just this, but we are going to stay in the field that we know the best.

Representative COLE. To design and construct a gas-cooled reactor for the Commission; is that the one at Arco?

Mr. KIMBALL. Yes.

Representative COLE. How is that progressing?

Mr. KIMBALL. We just started on it and we think quite well. We have only had a few months on it, and we are designing the core, and doing the preliminary engineering work on it.

Representative COLE. Can you tell me roughly when it will be tested out?

Mr. KIMBALL. We hope to have it running in 30 months, but there are a lot of problems. We could not give you a firm schedule on it now.

Representative COLE. Two and one-half years?

Mr. KIMBALL. Yes.

Senator PASTORE. How big will it be?

Mr. KIMBALL. We have not decided on the size of it yet. What we want to prove first is the feasibility of running a turbine with these hot gases. The size of the first one is not of great consequence. It would be the principle of being able to operate it. As a matter of fact we have not decided on the power level.

Senator PASTORE. Do you not have a lot of information from the one in Calder Hall, in England?

Mr. KIMBALL. It is a little different cycle than the one in Calder Hall. The one in Calder Hall uses the hot gases to transfer heat to

the water, and then that water forms steam. In our concept we are going to have the hot gases to drive the turbine directly. We would not have the heat transfer problem.

Senator PASTORE. As far as you know, there is nothing along the Calder Hall type being contemplated in this country?

Mr. KIMBALL. I cannot speak to that.

Dr. BIEHL. I cannot either.

Representative PRICE. I just want to say that I regret that I was not here earlier to hear Mr. Kimball make his statement. Certainly, I am happy to see him before the committee.

Mr. KIMBALL. We would like to invite this committee to come to California, and I would suggest this would be a good time to get out of Washington and see us operate this reactor.

The CHAIRMAN. I think that you have made a great contribution, Mr. Kimball. This committee has always urged that we develop small type reactors that could be placed all over the country for different purposes. I can see, for instance, where a hospital possibly could not purchase one, but a group of hospitals could purchase one, and then you can have isotopes, with a short life, and they would be immediately available for all hospital purposes.

It looks to me like a very helpful instrument.

Representative HOLIFIELD. I was interested along that same line. Do you see a great use for this in the industrial field, in testing of materials and so forth?

Mr. KIMBALL. Yes.

Representative HOLIFIELD. Have you already had some interest from the industrialists in this type of thing?

Dr. BIEHL. Particularly from the oil companies, there are about half a dozen, and I think they consider their interest proprietary, and so I should not discuss it.

Mr. KIMBALL. We have had great interest from a number of commercial companies for process control, who have been out to talk to us about this reactor, or possibly a little larger one.

The CHAIRMAN. The oil companies are using isotopes pretty generally.

Mr. KIMBALL. They would not necessarily use isotopes, but you can run material through this reactor and detect any variation in the quality on the meters instantly. That is rather than putting them through prolonged chemical analysis.

Representative COLE. You mean when Dr. Biehl says that the oil interests might be proprietary and therefore he cannot discuss it too openly—does that mean that in the oil trade some of them can conceive of a function of this reactor which will be advantageous to them in the oil production or refinement and some of the processes?

Dr. BIEHL. Oil refinement, yes.

Representaitve COLE. Which they would want to withhold from competitors.

Mr. KIMBALL. They have told us their problems and told us what they want to do, and we have had quite a lot of interest from them.

Senator PASTORE. What kind of a sales program have you initiated with reference to these things?

Mr. KIMBALL. We have gotten in touch with most of the universities of the country, and a number of the hospitals, and the industrial process control has been sort of growing by itself at the moment.

The CHAIRMAN. I understand that 21 universities have already requested, through AEC grants, or expressed an interest in this reactor with the thought of purchasing one. I believe that you gave the list as 21.

Mr. KIMBALL. Twenty-six of them have applied for it. Now, they have to be qualified to teach nuclear engineering, so the AEC has to check with them to see what their capabilities are. We hope to have part of that list released within the next month or so.

The CHAIRMAN. They would have to do the same thing on a hospital application.

Mr. KIMBALL. No, the hospital would not have to apply to the AEC.

The CHAIRMAN. I mean the AEC would not know about a hospital. They would come directly to you after they met all of the requirements of safety and everything else. You can just sell it to them across the counter.

Mr. KIMBALL. We have to get licenses from the AEC first. We can sell them directly to them then.

Senator GORE. Mr. Chairman, I would like to observe that the country could do with more adventuresome men like Mr. Kimball.

The CHAIRMAN. I agree with you on that.

Thank you very much.

The next witness this morning is Prof. V. Lawrence Parsegian, chairman of engineering faculties and professor of nuclear engineering of Rensselaer Polytechnic Institute, Troy, N. Y. We are glad to have you with us this morning.

STATEMENT OF V. LAWRENCE PARSEGIAN, CHAIRMAN OF ENGINEERING FACULTIES AND PROFESSOR OF NUCLEAR ENGINEERING OF RENSSELAER POLYTECHNIC INSTITUTE, TROY, N. Y.

Mr. PARSEGIAN. The past 9 years of my working years have been closely associated with the atomic power program including over 4 years with the Atomic Energy Commission. As with so many others in similar positions, the work has involved considerable effort to attract the support of industrial and university groups to aid the atomic program.

This experience has brought intimate awareness of the handicaps that beset atomic energy. The awareness has become even more focused by my present activites at Rensselaer Polytechnic Institute, where a major nuclear teaching and research program has been developing.

I have accepted the invitation to appear at these hearings specifically to speak to the problem of information controls, which problem still poses particularly serious handicap to the progress of atomic energy.

Through the declassification program, a large volume of technical information has been released by the Atomic Energy Commission. Under the tripartite declassification agreement, Adm. Lewis L. Strauss recently announced that there will be still more release of information. All this is to the good, and the Commission is to be commended for this approach.

It appears that the Atomic Energy Commission has done about as much declassifying as it may safely undertake to do on its own responsibility, within the spirit and framework of the present Atomic Energy Act.

The handicap I refer to does not arise from lack of enough declassified reports. Rather, it arises as a result of the restrictions that are inherent to the concept that reactor technology is "born classified." This means, in effect, that only the relatively few are permitted to know the status and problems of current reactor technology, and only these favored few are expected to have new ideas on developing these systems.

The concept, that reactor technology is "born classified" is the same one which the McKinney panel—the panel on the impact of peaceful uses of atomic energy—deplored in its recent report to Congress.

In my opinion, these limitations strike at the very roots of the elements that make for progress after the American pattern and should be eliminated as quickly as possible.

I believe that this concept should be altered by revisions to the Atomic Energy Act of 1954. Revisions are needed to make the act a more positive and enabling instrument for current needs, because events have moved so fast since 1954.

Specifically, I urge that the act be revised to clearly remove all technology that contributes to the development of nuclear reactors from the classified realm, excepting information which is useful only to weapons and to the military program.

Perhaps there should also be reorganization to transfer to the defense agencies all weapons aspect of atomic work, in order to assure that this area will remain under proper security control. Such revision would undoubtedly also have immediate value toward modifying the restrictions on materials controls and on patents.

A revision of this type entails loss of some useful information to unfriendly powers; therefore, Congress must share responsibility for the change.

In balancing such losses against the gains, one must consider many factors. To begin with, information we now have would normally depreciate rapidly and become replaced anyway. In a rapidly growing technology, it is not the information one has in hand, but the rate at which one accumulates more and better ideas that makes the difference.

How does one assess the loss when solutions fail to come because not enough people become aware of the specific problem? What is lost when a person conceives a brilliant invention and the invention is not born under secrecy controls?

How seriously is a nation crippled when only a fraction of its technical manpower is encouraged to have ideas? Do new technical concepts come more readily from cleared people who too often become tied down to specific engineering projects with "the nose to the grindstone"? Or are these more likely to come from people who are watching the full picture from the sidelines?

I should like to note the status of atomic development as I see them.

The act of 1954 recognized our loss of monopoly of the atom, and opened the way for industrial participation in the program. The President's atoms for peace proposal, and the succeeding steps taken by the Atomic Energy Commission, substantially increased the global scope of our atomic thinking.

More important still, certain nations have set firm course to achieve large blocks of atomic power as quickly as possible to strengthen their

national economy. Their desperate need for atomic power, to make up for the lack of fossil fuels, demands faster progress than is required by our own domestic power needs.

Even now there is intensive competition among several nations for these atomic markets. The United States still enjoys competitive advantages, but these may not go on forever. The very abundance of our fossil fuels, which reduces the urgency for domestic atomic power, can seriously prejudice our relative rate of progress unless we take bold steps to assure the contrary.

This commercial competition is intimately tied to our national defense needs. With the disappearance of our monopoly of the atom, it seems clear that the Nation's defenses must depend more and more heavily on industrial development of the atom rather than primarily on atomic weapons.

The past two wars clearly demonstrated that success in arms was finally made possible only as a result of the superior vigor of our technical and industrial economy. It is not likely to be different in a new conflict. Therefore, whatever detracts from the growth of our technical and industrial economy detracts from our defense potential.

As a simple example, successful fleets of atom-powered warcraft are likely to come into being only when they can be supported by technology, experience, materials, techniques, and equipment that are developed and tested by thousands of industrial firms on tens of thousands of civilian applications of the atom.

What all this should mean in terms of money support to the atomic program is not the subject of this statement. With this international scene in mind, however, I am led to question whether we are geared, by national policy and by implementing devices, to support our industries to the full.

Are we making full use of the technical strength of our universities and of our vast industries to support the atom, and to integrate the atom into our technological and industrial economy? I think not.

Stiff competition and superior performance are not new to American industry. But competition under Government control is new, and could cost us heavily if the controls are overdone, particularly information controls at the "idea" stage.

Perhaps an analogy will be useful, between the atomic "baby" and our more personal experiences. This "baby" was born in the midst of war and destruction. There was need for unusual care and spoon feeding during those early years, for this most promising child.

Today the child is nearly 18 years old, however, and in the fullness of young manhood. He has all the restlessness and impatience and appetite and growing pains of his age. He cannot be continued under protective custody, spoon fed, or for that matter shovel fed, if he is to achieve the superior stature which his brother industries achieved without restrictions.

He cannot be unduly restrained by the qualms of uneasy parents; he must be treated as a normal young man who is prepared to go to college, and to assume his rightful, individual role.

This does not mean that he can be cut loose from parental responsibility either with regard to financial support, special defense responsibility, or unusual safety controls. It does mean, however, that he

must not be crippled by restraints on his thought process, on his growth, or on his exposure to the normal hazards and opportunities of life.

Returning to the main theme, classification applied to a vast area such as reactor technology, requires controls that are extensive, expensive, complex, confusing, uncertain of results, replete with inconsistencies and long delays, irritating, divisive, and very difficult to apply.

Worse than that, by their very intent such controls are designed to severely limit the number of people who can participate in the "idea" or exploratory research stage of atomic development. They are premised on the false theory that new ideas will be generated only among select cleared personnel.

For example, secrecy has excluded the great majority of men in universities from the current problems and exploratory research technology. College faculties refuse to become involved in classified research which they may not freely share with colleagues and graduate students.

Access permits, and the L clearance scheme appear, as far as I can determine, to have little use on a college campus where free discussion, free inquiry, and open exploration are the very lifeblood of progress.

It should not be forgotten that atomic energy was conceived in the university and that much of the most difficult engineering problems connected with atomic power were solved by university professors. Possibly the new ideas for which we are searching, with which to harness atomic power by fusion, will also come from some university professors not now connected with the project.

A process involving classification and extensive declassification is likely to help our enemies more than our own people. Only foreign groups will make the effort to piece together all the bits of unclassified information that together often make up a classified picture.

Another serious weakness that results from information being "born classified" has to do with invention, patent rights, and exploitation of patents.

To begin with, relatively few patentable ideas seem to have been generated with classified reactor technology, despite the fact that this presents a "happy hunting ground" for new ideas. It is my opinion that this is partly a result of secrecy restrictions, and partly because the act has excepted atomic inventions from normal patent practice.

Even the ideas that are developed cannot be easily patented so long as they are classified. Worst of all, our Government and our citizens are losing out because they cannot make disclosure whereby to obtain foreign patent rights. Our patent position abroad is seriously weakening industry's competitive position.

It is hoped that when reactor technology is declared unclassified, the patent sections of the act will also be changed to bring the atom within normal patent law and thereby to give industry the inducements and help that are needed in this international race.

In conclusion, I would like to urge that Congress consider another revision of the Atomic Energy Act, one that will clearly define and limit the authority and role of Government, in order to reduce controls to the necessary minimum. In particular, there is need to elimi-

nate the concept that information in the reactor field is "born classified" in order to bring to the atomic effort the full support of our colleges and of our industries.

The objectives of such revision would be to afford maximum freedom to industrial initiative and responsibility, consistent with national security and well-being and to define the Government's role as one of aiding and safeguarding, not managing, civilian development of the atom.

The CHAIRMAN. Thank you very much, Doctor.

Doctor, you pose a question that has bothered us here for many years. That is—the difference between what is necessary for security and what can be made available to the public in general. It is one problem that has always troubled me.

You particularly refer to the reactor program. It is my general understanding now that almost any individual that comes in and makes application to build a reactor can build one under the information that he can receive. What you would advise us to do, or advocate us to do, is to take all restrictions off of everything, including the core?

Mr. PARSEGIAN. In order to permit him to build a better reactor and not to copy one.

The CHAIRMAN. Then, you have no complaint about the present information. What you are thinking of is the future information.

Mr. PARSEGIAN. It is our competitive position in developing better reactors.

The CHAIRMAN. To keep the channels open so that any new idea that is born in the man's mind, or in teaching, can be discussed freely.

Mr. PARSEGIAN. It is my opinion that building reactors by copying present systems will lose to us the first position that we now enjoy.

The CHAIRMAN. You will lose the improvements that might be born in a man's mind; is that right?

Mr. PARSEGIAN. Yes; for the reason that I feel the reactor systems we now have are simply the beginnings of truly successful reactor systems.

The CHAIRMAN. You made one recommendation, that we turn back to the military, control of all of the making as well as the holding of the weapons. Was that the idea in your statement?

Mr. PARSEGIAN. In order to assure that the weapons aspect is clearly protected by secrecy controls.

The CHAIRMAN. Well, I have always been one of those who have advocated and believed in civilian control of this whole program. Of course, in the original act was where we had the trouble and the fight here in the Congress and throughout the country.

Most of the teaching profession, I believe, throughout the country advocated at that time that we set up a civilian agency to handle this whole program. I do not know what your position was in those days. What was your thought when we wrote the original act as to civilian control?

Mr. PARSEGIAN. That paragraph was put in parenthetically, simply to suggest that it is possible to protect secrets connected with the weapons program by separating it from the main job, if that should be considered the best way to do it.

The CHAIRMAN. It is all neutrons and protons and when you get into that field, how are you going to control it?

Mr. PARSEGIAN. There are safety controls that we have to maintain for protecting the civilian population from neutrons and protons. As far as making sure that our weapons program is kept secret, I think an organizational device can be set up to assure that. That was my point.

Senator PASTORE. I think that you have made a fine presentation and I congratulate you for it. But if you refer to page 8 of your manuscript, the last paragraph there:

> Even the ideas that are developed cannot be easily patented so long as they are classified. Worst of all, our Government and our citizens are losing out because they cannot make disclosure whereby to obtain foreign patent rights. Our patent position abroad is seriously weakening industry's competitive position.

Could you be more specific about that? Have you experienced any instance where that is so, and if so, what is the instance?

Mr. PARSEGIAN. I cannot give specific instances, but I understand that there are patent applications being made in foreign countries which are essentially American ideas. But our people, because of the status of patents and because they are not permitted to make full disclosure, are restrained from going as far as they should in seeking foreign patent protection.

Senator PASTORE. I have heard the same thing, but every time I try to pin it down I cannot do it. From whom did you hear it? You mean a person can apply for a patent here, or cannot apply for a patent here and yet abroad these patent ideas are being taken over by other industrial firms and being patented there to the exclusion of American firms?

Mr. PARSEGIAN. It is very easy to think up a patent application which is in the classified realm in our country.

Senator PASTORE. For that reason you cannot patent it?

Mr. PARSEGIAN. For that reason disclosure cannot be made by our citizens to permit them to find foreign patent protection. Whereas the foreign people are not limited by any such thing.

Representative COLE. They, nevertheless, can patent that idea in this country?

Mr. PARSEGIAN. Yes; they can do that.

Senator PASTORE. Now, they patent this idea in this country, but they cannot reveal what it is. How can anybody get it abroad so they patent it there? What is the problem really?

Mr. PARSEGIAN. They simply put two and two together.

Senator PASTORE. I have been trying to put two and two together. You mean a person has an idea here that falls within the classified realm, you concede the fact that he can patent that idea through our process; is that right?

Mr. PARSEGIAN. Yes.

Senator PASTORE. You would like to see that person do it abroad; is that the point?

Mr. PARSEGIAN. Yes.

Senator PASTORE. Now, why is he losing position abroad for lack of being able to do this?

Mr. PARSEGIAN. Because he will not have the patent rights to sell these things abroad. These will reside with foreign groups.

Senator PASTORE. What would be your solution to this problem? Naturally, for many to do this abroad, classified information becomes unclassified information; is that basically the problem?

Mr. PARSEGIAN. That is right. My solution is to recognize that reactor technology is no longer a secret to the world and, also, that the initial thoughts that we have had—about patents in the atomic realm being excepted from normal patent law—should be reconsidered.

Senator PASTORE. Do I understand you correctly: Basically your trouble is not in patenting, but your problem is in declassifying information that is not essentially weapons information?

Mr. PARSEGIAN. Yes; and classifying it at the stage where ideas and inventions are generated, which is the worst place of all to classify them.

Senator PASTORE. But you cannot give one instance, or one example where such an instance arose to the detriment of an American businessman.

Mr. PARSEGIAN. I have not actually sought that. These are things that I have heard from patent people and I have not actually asked for specifics.

Senator PASTORE. Would you say it falls within the realm of being academic argument more than a practical situation?

Mr. PARSEGIAN. Oh no, it certainly is as "practical" as anything I know. The setup permits that so easily.

Representative HOLIFIELD. In clarifying my own thoughts on this line of questioning, what you are saying is that we have a method under the act by which any invention is screened by the Atomic Energy Commission for its security aspects. If it is deemed to be of particular benefit to the national security, particularly in the weapons applications, this can be put in the deep freeze, so called, as far as public knowledge is concerned.

Now, the individual who discovers that can have a domestic United States patent equity filed.

Mr. PARSEGIAN. Yes.

Representative HOLIFIELD. But he cannot protect himself in foreign fields because our security laws prohibit him from making known in France, let us say, or England these facts which have been now classified as being of national security import.

Mr. PARSEGIAN. Yes, sir.

Representative HOLDFIELD. But if some other scientist a year later puts two and two together as you say, he can go and disclose this to the public and obtain a patent right in England or in France and thereby our system in effect, defrauds the original conceiver of the idea from his patent rights abroad.

Mr. PARSEGIAN. That is right.

Representative HOLIFIELD. That is what you are saying?

Mr. PARSEGIAN. Yes, sir.

Representative HOLIFIELD. I think that condition exists and there is no doubt about that. I want to go a little further into your statement that you believe now that reactor technology has achieved a point where it should be declassified, completely declassified.

Mr. PARSEGIAN. Yes, sir.

Representative HOLIFIELD. That would mean, would it not, that reactors which become efficient in the production of weapons material would also be declassified.

Mr. PARSEGIAN. Yes.

Representative HOLIFIELD. In order to reach that position which is a position of saying that we no longer can conceal if we ever could,

technical information in the special material producing field from other people, it means that we have to forsake a position of thinking that our security laws in the reactor field are actually of benefit to us. It means that we have to accept the position that it actually now, becomes more of a detriment to us——

Mr. PARSEGIAN. Yes, sir.

Representative HOLIFIELD. Than it does of aid to the enemy.

Mr. PARSEGIAN. Yes, sir.

Representative HOLIFIELD. Do you premise that on the fact that we know the enemy or a potential enemy already has atomic and hydrogen weapons, and, therefore, we are quibbling now about the production of, let us say, uranium 235, plutonium and other materials which might be used in weapons when we know that they know how to produce it? The only thing that we would actually be withholding from them, if we are withholding anything, is a degree of efficiency in the production of that material.

Mr. PARSEIGAN. Yes, sir.

Representative HOLIFIELD. Is that your thinking?

Mr. PARSEGIAN. Yes, sir.

Representative HOLIFIELD. Does your thinking go further to say that such advantages as we are withholding from them in the full evaluation of this problem, is insignificant as to the good that would come if the thing was thrown wide open?

Mr. PARSEGIAN. Yes, sir.

Representative HOLIFIELD. Is that your thinking?

Mr. PARSEGIAN. Yes, sir; American industry can compete, and compete well, in this area also, as it has in every other area, if it is given freedom to do so, and if the full technical strength of the country, in industry and in universities, is brought to support the program. That is my point.

Representative HOLIFIELD. We have passed the point of any return by trying to keep these reactor methods secret, you think?

Mr. PARSEGIAN. Yes, sir.

Senator PASTORE. I am a little confused here. You still maintain that you have to have a distinction between weapons information and reactor information. Are you suggesting that we declassify the whole field now?

Mr. PARSEGIAN. Oh, no. Let us keep the weapons secret.

Senator PASTORE. The chairman has indicated the problem is where you draw the line. Where do you draw the line specifically? Are you saying that all information with relation to materials should be declassified?

Mr. PARSEGIAN. Yes, sir; by all means.

Senator PASTORE. You take that position?

Mr. PARSEGIAN. Yes, because in our normal setup, our defense weapons may be kept secret, but certainly our materials program that contributes to the development of our artillery and other weapons are not. Materials cannot be kept secret and still allow the United States to have the superior position that it now has.

If we simply limit the secrecy to the design of weapons and other instruments that are specifically a part of the weapons category, and realize that the materials are the core of the entire reactor program, and that the materials problem is the one that is either going to give us the advantage in this country (or is not going to give us the ad-

vantage in this country in the long run), that is the important thing.

The CHAIRMAN. Suppose that you found a material that would hold the neutrons completely, by being very light in this field. Would that be of a military value if the other country knew about it? That would be a reactor. How are you going to arrive at this thing? I just cannot follow you on that.

Mr. PARSEGIAN. It would have a military value in the way that a better alloy permits us to build a better gun. However, that alloy in our industrial use is worth a great deal more to the Nation than simply in the manufacture of guns.

It is in the use of that alloy in the manufacture of the tens of thousands of civilian things that leads to the development of the next improved material which would be available to our next set of guns.

The CHAIRMAN. You put it on a value basis. It is worth more to civilian industry and private enterprise to develop more ideas than it is to have secrecy in this, although it is a part of the weapon.

Mr. PARSEGIAN. Yes; and it is premised, as I stated, on the fact that our weapons program offers us one line of defense. Our industrial economy offers us probably an even more valuable line of defense.

Senator PASTORE. Have you ever discussed this matter with people in authority on the Atomic Energy Commission, the point that you are raising now?

Mr. PARSEGIAN. Oh, yes.

Senator PASTORE. And what has been their reaction to it?

Mr. PARSEGIAN. It was mixed.

Senator PASTORE. Well, then, tell me this: What are some of the arguments that they have interposed in opposition to the view that you take? I ask that just so that we can open this thing up to further discussion and provocation of ideas.

Mr. PARSEGIAN. I was also with the Atomic Energy Commission and I know how they try their best at the job that is set out for them. Every one of those men is doing his darnedest to do the thing that is set as a national policy. The technical men who are part of the program, the scientists, chafe under this secrecy system. They have no use for it. They are keenly aware of the inconsistencies that come with this sort of thing, and irritations. The technical men of the Commission I think are probably divided, partly because they also have the administrative job. The purely administrative people, I believe, feel that they have a policy cut out for them.

I feel that there is a policy cut out for them by the present tenor of the Atomic Energy Act, which goes on the assumption, as I see it, that atomic energy primarily represents defense and weapons and United States Government interest, and the rest of the country is only permitted to do some things.

Representative COLE. I confess I am a bit confused now. In view of your comments in response to questions, I am confused as to what your position is. I do not know whether you feel that secrecy should apply only to weapons, or to any other aspect of the atomic program which relates to our military program, or our international security.

I am confused because in your statement you said that you felt everything should be born unclassified except those matters relating to weapons and to the military program.

Mr. PARSEGIAN. This would be weapons design.

Representative COLE. Would you not also include in that concept aspects of the atomic program which are essential to our national security as well as weapons?

Mr. PARSEGIAN. For example, the design of the power unit for the submarine?

Representative COLE. Exactly.

Mr. PARSEGIAN. That is right. I would leave out the design of that reactor that is used in the submarine, but you will never get a truly advanced reactor for that submarine unless the materials problem that contributes to the development of that unit is thrown wide open for us to work on.

Representative COLE. You do agree, then, that any aspect of the atomic program which has a direct and vital bearing on the national security should be classified?

Mr. PARSEGIAN. With the improvement of that concept of national security to include this fact, namely, that industry is also a major element in our national security.

Representative COLE. I do not see much difference between your thinking and the present situation except that as presently required by the law, this concept of making secret and secure information related to our national security is born classified.

Mr. PARSEGIAN. That is right.

Representative COLE. I would call that concept of protecting the military aspect of atomic energy the "horse." Under the present law the law says that horse shall stay in the stable until those in responsible authority determine it is safe to let the horse out.

Mr. PARSEGIAN. Yes, sir.

Representative COLE. Your concept is that that same horse may be allowed to run around until somebody discovers that that horse is essential and then you put him back in the barn, when it is too late. The information will have been disclosed.

Mr. PARSEGIAN. What I am after is "bigger and better horses."

Representative COLE. That is a concept of making certain the atomic information relating to national security——

Mr. PARSEGIAN. I am less interested in saving that horse than I am in a better breed of horses.

Representative COLE. That is where we disagree.

Senator PASTORE. And if you do not let him out, you are not going to propagate the breed, is that right?

Mr. PARSEGIAN. That is right.

Representative COLE. We disagree because under your concept, you are not sure that you are going to develop a better breed of horses than the one you have got in the barn.

Mr. PARSEGIAN. I am as sure as I can be that American industry has arrived at its present stage only because of initiative and "idea" men. That, sir, has been our experience.

The CHAIRMAN. Through research and development?

Mr. PARSEGIANK. Yes, sir.

Representative COLE. It is strange because yesterday somebody from the Commission indicated that the displeasure of industry with the declassification was that too much of it was being declassified and it was coming to them too fast and they could not absorb it and could not digest it.

Now, your thinking is just the opposite.

Mr. PARSEGIAN. They could not digest the volume, sir, and nobody can. This is my point, that we have tremendous volumes of stuff being declassified, but the initial idea stage stays closed. Therefore, the material that is declassified is essentially depreciated information.

Representative COLE. What has been your experience with the delay in declassifying material? Has there been any in recent months?

Mr. PARSEGIAN. The industries that are in the atomic program are less handicapped by delays. My experience has been largely with those who have been in the program and cleared. Therefore, they had access to the material.

The other experience had to do with new companies trying to get into the business. Here, it is possible under the access permit arrangement to allow them to come in. However, at the moment, the most serious problem that I see is cutting out university faculty almost completely from access to this area on an open basis, yet, they are considered to be our first line of "idea" men.

Representative COLE. Is there general concurrence in the university field with your point?

Mr. PARSEGIAN. I believe there is.

Representative COLE. Can you indicate why you come to that belief?

Mr. PARSEGIAN. I have talked to them and they take the same position, as far as I can determine. Also I was responsible, when with the Commission, for the administration of the research and development contracts in the northeastern universities, so I had contact with many of them.

Representative COLE. As far as I know—I am probably wrong—you are the only one representing the university group who feels as you do. There may be others. I don't know about any other university that has expressed the concern that you have expressed. Can you name any other university?

Mr. PARSEGIAN. I think I am the only one who has taken the trouble to express a feeling which is quite general.

Representative COLE. If it were a matter of serious concern, certainly other universities are as interested in this program as you, and why is it that they have not expressed themselves as vocally as you have?

Mr. PARSEGIAN. I think they expressed themselves when MIT, I understand, refused to take on a classified project in the fusian area.

Representative COLE. That is one instance of concurrence.

Mr. PARSEGIAN. And it is as serious an indication as I can think of, sir, because there are many other universities that would do the same thing if they were asked to take on that project. I do not know of any university that would care to permit a lock and key to be applied to its operations, and still expect to be considered first-rate universities.

The CHAIRMAN. Senator Gore?

Senator GORE. I have no questions. I found your statement very provocative.

The CHAIRMAN. Mr. Price.

Representative PRICE. You do feel, and as far as you are concerned you know, that you are expressing the almost general view of most universities, of scientists in universities?

Mr. PARSEGIAN. Yes, sir. I have letters from them which they wrote to me after my article appeared in the New York Times maga-

zine some months ago. I wish that some of them had put into public print what they put on their letterheads to me and in their oral statements, particularly.

The CHAIRMAN. Doctor, I read your article and also the reply by Admiral Strauss. If you have no objection I would like to put in the record at this point.

Mr. PARSEGIAN. I have no objection.

Representative COLE. Let's put both of them in.

The CHAIRMAN. Yes, if there is no objection, the statement by the doctor and by Mr. Strauss on this subject will be placed in the record at this point.

(The documents referred to follow:)

[From New York Times magazine, October 14, 1956]

IS THERE AN ATOMIC CURTAIN?—A DEBATE

A nuclear engineer says we are hampered by secrecy in the race for atomic power. In rebuttal, the AEC's Chairman says all the needed information is available

Is our atomic-energy program hampered by secrecy? The author of the following article says it is. He was Director of the Research Division, New York Operations Office, AEC, in 1950–54. He is now head of the engineering faculty and a professor of nuclear engineering at Rensselaer Polytechnic Institute. The Times asked Lewis L. Strauss, Chairman of the AEC, to comment. Mr. Strauss' rebuttal appears at the end of this article.

(By V. L. Parsegian)

It has become clear that Soviet scientists and engineers are making very substantial advances in the peaceful application of the atom, especially in the development of atomic powerplants. This is bad news for the United States; we appear to be losing our lead over the Russians in the atomic power race, and under present conditions the Soviet rate of progress is bound to become even greater in the future.

American concern over our status in the contest is reflected in the proposal earlier this year by Thomas E. Murray of the Atomic Energy Commission that $5 billion be spent during the next 5 years to speed our atomic power program. In addition, serious efforts have been made to release more atomic information.

The significance of our situation in the atoms-for-peace race is pointed up by the shortage of technically trained personnel. The fact that we badly trail the Russians in the number of scientists and engineers trained per year in all fields has been highlighted in the press and in public announcements.

Commissioner Willard F. Libby of the AEC recently stated to the deans of engineering colleges that in 1954 the U. S. S. R. turned out 280 engineers per million of population to our 136 engineers. The ratio could be even higher in the case of atomic scientists in view of the high priority the atomic program is receiving in Russia. He estimates our own atomic needs to require 2,000 scientists and engineers per year, or about 10 percent of all students receiving engineering degrees each year.

Where these are to come from no one knows. The AEC has made important overtures to colleges to help resolve the problem. The recent announcement by Chairman Lewis L. Strauss of the AEC, to the effect that that agency will give up to $350,000 for equipment to each of a number of schools to help develop educational programs, was very welcome indeed.

These steps, while important, still do not reach to the roots of the handicaps that have brought about the present shortage. The principal handicap has been the policy of secrecy which clouds and divides and obstructs the educators and industrialists of the Nation.

Our program is handicapped chiefly because the AEC's policy of secrecy has hampered the training by colleges of future nuclear scientists and engineers. The secrecy has lowered the quality of the training and has lessened interest in it, thus discouraging many people from entering the field who should be in it. The program will continue to be handicapped because, in spite of some recent

modifications of policy, secrecy will still deny to students much information on the latest nuclear developments and engineering techniques essential to their proper training.

It is true that much information has been declassified, but this has not helped enough. Although the report last February of the Citizens Panel on Peaceful Uses of Atomic Energy recommended, among other things, that all reactor technology (information on the construction of nuclear reactors and the behavior of materials in them) be removed from the restricted list, that has not been done. A large number of secret documents remain out of reach.

After that report the AEC announced that 10,916 reports and papers were being declassified. But 19,857 other documents are still kept in the secret or confidential categories and denied to anyone who is not granted personal clearance to receive them. Even worse, the information controls that are being continued, and extended, strike at the very roots of the elements that normally promote faculty interest and participation in new technology.

Take the situation at Rensselaer Polytechnic Institute. Like other engineering colleges, the institute has trained leaders in every important engineering field. It has been doing this since 1824 and wants to do the same for nuclear engineering, but the handicaps have been many and serious.

During the war, several faculty members participated in the atomic bomb project. They were permitted to do this under a Q clearance, which meant that they had been carefully investigated and found worthy of receiving atomic secrets. Some of them returned to the school after the war and were permitted to retain their Q clearances in order to maintain limited contact with new developments in the atomic area.

But these same men found that they soon lost touch with the atomic program. The nearest library where classified documents were available was 20 miles away. If they knew what documents to ask for, they could request them by mail; but the restrictions and inconveniences were too irritating and too time consuming to encourage very much of this. The men had all they could do to keep up with the usual technical publications, without trying also to dig out information that was kept under lock and key.

The net effect of all this has been to separate these men almost completely from classified atomic developments, despite the fact that they nominally still have Q clearance and can be permitted access to classified documents.

Since the end of the war several other faculty members were given Q clearances, mostly in connection with research projects sponsored by the AEC. The effect has been the same; nominal access has not actually led to effective contact with the atomic program.

Sometimes the system produces an ironic twist. On one project, several scientists who do have Q clearances and some knowledge of classified work are associated with a Professor X who does not have clearance; the reason is his citizenship has not yet been granted. However, Professor X, a renowned scientist, has an embarrassing faculty for producing ideas that fall in the classified realm; in effect, he thinks classified thoughts. His colleagues cannot discuss his own ideas with him—not because they aren't cleared, but because he isn't.

Because of pressure from industry, the AEC in 1954 decided to increase greatly access to classified information. This was done by creating a "gray" area of information which was classified "confidential"—that is, not as secret as "secret." A good deal of reactor technology will eventually find its way into this gray area. A new L clearance was created to permit access to this gray area, and could be given to individuals whose police files did not contain derogatory information.

A company or college can request and obtain an "access agreement." Rensselaer Polytechnic Institute now has such an agreement, whereby the college can request additional Q clearances at the rate of $265 a head, and L clearances at the bargain rate of $15 a head. But even if additional faculty clearances were obtained, this would only increase the state of confusion—because under present policy the information could not be shared with students. Even in lecturing before graduate practicing engineers the writer has frequently had to confine his remarks to reading from card notes, lest he say more than he should. This would have to be followed with an apology such as: "The Russians must know more than this, but I am not permitted to tell you more."

A professor cannot place himself in the position of holding a substantial amount of classified information in his head which he cannot share with his associates and students. The law is very severe on those who divulge such information

improperly. It is so much easier to play it safe, to consider most of it classified and therefore to avoid discussions althogether.

One may ask, Are not the nuclear engineering staff and students sufficiently separated from the other faculty and students so they can be given clearance as a group to receive classified information? The answer is no, they are not.

Nuclear engineering is not a new professional subdivision of engineering, set apart from the rest. Instead, it is a new area of technology the development of which is completely dependent upon men who are trained and are being trained in the basic professions of physics, chemistry, metallurgy, and so on. Special problems are involved in this field, but the basic professions and the nuclear training go hand in hand. It is obivous that it would be impractical to attempt any system of clearances when the numbers of teachers and students involved are so large and in such a state of flux from term to term.

To carry the question one step farther, why cannot the institute request "L" clearance for the whole school, including the students, assuming it had the money to do so? This would still exclude the many foreign students on the campus, who come to us from 50 countries, and even some distinguished noncitizens on the faculty. It would bring complete Government secrecy control to the campus, an impossible situation which no school could tolerate. And it would leave the basic problem—actual ready access to information as distinct from mere clearance—still unsolved. Neither the "Q" nor the "L" clearance automatically brings to any individual the information he needs; he has to ferret it out under very awkward circumstances. Atomic technology cannot become an intimate part of college life until this technology can be dealt with in the open technical journals.

The present state of affairs ignores the fact that the atom was born and brought up in the university. From meager beginnings in the 19th century the atom grew in university laboratories of many lands to become the foundation for the technical progress of the past half century.

The university character of atomic science did not change with the coming of the bomb. The design of the reactors, the vast research and development that accompanied them, were largely accomplished by scientists from our universities or by foreign university men who had come to this country. But today the AEC wall of secrecy largely excludes the very institutions that had the most to do with the development of atomic science.

Recognizing the difficulty of training nuclear scientists and engineers, the AEC opened summer institutes to help train college faculty members to teach nuclear engineering in their own schools. The training programs offered by the Oak Ridge and Argonne Laboratories have been good as far as they go—although they tend to detract from a realistic approach to the problem. Further, the AEC will provide fissionable material on loan for use in setting up subcritical assemblies and research reactors for purposes of instruction. Colleges are permitted to participate, up to a point, in many aspects of nuclear technology.

These are all helpful and welcome. But one must not forget that training for the nuclear field is largely a graduate program. As such it can thrive only where the campus provides an abundance of courses and graduate seminars and theses of an advanced caliber. These in turn can be derived only from the experience and familiarity which faculty members are permitted to enjoy either through study or from their own research.

Moreover, the problems of the low- power instructional reactors are poles apart from major problems—information on which is still largely restricted—of chemical engineering, metallurgy, and behavior of fuels and other materials that limit the power reactor.

It is argued by some that the AEC secrecy policy may be due to a belief that this country still possesses a great advantage in technology unknown to other nations. How much justification is there for such a belief? After all, Soviet Russia exploded atomic bombs some years ago, and later, hydrogen bombs. The Russians seem to understand well the problems of thermonuclear power.

That our secrecy has not hindered atomic progress abroad was further confirmed by the international Geneva conference on the atom in August 1955. Many who attended, including members of the congressional Joint Committee on Atomic Energy, declared in effect that there were no significant secrets and expressed the hope that our secrecy controls would be greatly modified.

Aside from discouraging colleges from advanced work in nuclear technology, the present policy of secrecy has another serious effect on technical training. It retards the beneficial effects nuclear technology could have on engineering education in general. Nuclear technology demands the highest degree of skill,

and the atomic program could be the most important single factor in shaping engineering curriculums and techniques of the next several decades. But all of this may be delayed unless those responsible for the engineering curriculums develop familiarity with the full atomic power picture.

There are also broader objections to the present policy. The atomic program has cost more than $15 billion and has engaged the services of thousands of men of the highest skill. By comparison with any industrial experience this effort should have produced many innovations. Yet when a search was made to identify instrumental innovations that could be ascribed to the atomic program, the results were small considering the nature of the effort. Inbreeding of ideas within national laboratories and the absence of open discussion and competitive cooperation with industry seem to be the principal causes of this condition.

On the industrial side of the program much of our native inventiveness and skill is not being utilized. America's host of inventors, shopworkers, businessmen, and gadgeteers are mostly out of luck as far as real participation in atomic power development is concerned. This is a pity, since it was the daring and resourcefulness of these same people that nurtured the automobile, electronics, and every other major industry. In our race for atomic supremacy these gadgeteers, inventors, and Henry Fords are needed as much as the Einsteins. But the secrecy policy has shut most of them out.

What conclusions are to be drawn about the present policy? What should be done to speed up, intensify, and vitalize our atoms-for-peace effort in the face of all-out Russian competition?

There are very serious risks inherent in the present course. Alternative courses also have risks that must be weighed carefully. A single Government agency should not be expected to assume responsibility for all the necessary decisions without strong support—and even pressure—from an informed Congress and people. In particular, there is need for Congress and the people to participate more actively with the Atomic Energy Commission to determine:

(1) Whether our country does not lose much more by retaining secrecy than it gains.

(2) Whether it is not time to scrap all classification, and the need for clearances, on all work related to development of nuclear power and production reactors. The possible exception would be designs specific to submarine and aircraft reactors and certain materials that are specific to weapons.

(3) Whether it is not time to do much more to help bring the full support of colleges to the nuclear program. If we are to win the race, we must train many more physicists and engineers than we are now producing.

(4) Whether it is not time to reassess the role of the Government in the nuclear area. Perhaps we should consider a role in which the Government assumes responsibility for the strictly defensive needs of the country and for such minimum controls as may be needed over fissionable materials and military secrets.

In short, the Government should lower the barriers and enlist the full support both of industry and of the colleges. Our atoms-for-peace effort needs the help of all our people.

An Atomic Curtain?—Strauss' Answer

By Lewis L. Strauss

It is impossible to answer and correct all the erroneous reports, misapprehensions and allegations which inevitably appear in connection with an enterprise of such proportions as the Government's atomic energy program. However, Dr. Parsegian's article reveals such a degree of unfamiliarity with the matters with which he deals that I feel compelled to point out some of the more glaring of many inaccurate statements.

Dr. Parsegian begins his article with the statement that we appear "to be losing our lead over the Russians in the atomic power race." That statement, if true, would constitute something more than "bad news," to use his own choice of words. However, the truth is that—unless Dr. Parsegian possesses information about Soviet activities not known to our Government—the statement is lacking in any basis of fact.

As far as is known, Soviet Russia has just one nuclear powerplant, for which it claims a capacity of 5,000 kilowatts. Independent American nuclear scientists who have visited Russia and who have seen this plant describe it as of primitive

design. Its power output is only a small fraction of the useful electric power which we have been producing in our prototype marine reactors for upward of 3 years. Whatever else the Russians may have is unknown to us.

As to future plans which they may have announced, these must, of course, be regarded in the same light as other Communist promises and intentions until and unless they are made concrete. We recall what happened to other Soviet 5-year plans which were supposed to produce so many benefits for the Russian people. Dr. Parsegian's statement must be based on data not known to me.

The United States program of atomic power development represents the most comprehensive approach that is being made anywhere in the world to the problems and promises of nuclear power. This is in terms of research, development, and construction, or it can be measured in terms of numbers of scientists, engineers and dollars. We do not lag behind any other country. This is not merely my opinion; it is a statement which is supported by the facts and the published records of the Geneva Conference.

The United States has built and operated more atomic reactors of more types and sizes than all the rest of the world combined. We have already built 82 and some 127 others are either already under construction or planned—a total of 209 reactors. More than a third of these are power-producing types.

This broad program has developed in the short space of little more than 2 years, since atomic energy was released from the grip of Government monopoly by the Atomic Energy Act of 1954.

Dr. Parsegian makes repeated reference to what he calls the Atomic Energy Commission's "policy of secrecy" on scientific and technical information. I am truly surprised that, with the facts which are fully available to him, Dr. Parsegian should make such a statement. The facts are that since the Government's monopoly was ended in August 1954, and atomic energy was given to the people by Congress, a great volume of information long held secret has been released to industry, to laboratories, and to educational institutions by the AEC.

During the last 2 years the Commission has declassified not just the 10,916 reports and papers to which Dr. Parsegian refers but some 30,000 documents. These are available to Rensselaer Polytechnic Institute with which he is associated, as they are to all other such institutions. His statement that "information controls are being extended" is wholly contrary to the facts. All of the technical information on the peaceful uses of atomic energy, including power, is available to any American firm, college, or individual who can show need for it.

If Dr. Parsegian has ever had a need for such information and been denied it, there is no record of it in our files. The only information which is kept secret is that which deals with the military uses of atomic energy, and I am sure that Dr. Parsegian would not contend that colleges have need for that.

Most puzzling of all—in the light of the known facts—is Dr. Parsegian's statement: "The AEC's policy of secrecy has hampered the training by colleges of future nuclear scientists and engineers." I thought just the reverse was true.

The Atomic Energy Commission, as he must be aware, does have limited authority and resources to affirmatively engage in educational activities. Yet, despite this limitation, it conducts a vigorous program in cooperation with American colleges and universities for the training of nuclear scientists, engineers, and technicians. It is making a many-sided approach to the very serious problem of our national shortage of such skilled personnel. In this effort, the Commission has received rewarding cooperation and enthusiasm from many colleges and universities. I have never heard Dr. Parsegian's criticism from any other educator.

The activities being carried on by the Commission in this field at the present time afford courses of instruction to college and university faculty members, enabling them to learn the latest techniques and to employ the finest instruments of nuclear science at our largest laboratories. During this past summer the Commission's Argonne National Laboratory near Chicago and its Brookhaven National Laboratory on Long Island conducted courses for engineering faculty members.

Other faculty personnel have taken advantage of summer research programs at the national laboratories, or have taken leaves of absence from their faculty posts to study at those installations during the regular academic year.

Two graduate schools in nuclear technology, each providing 1-year courses, are conducted by the Commission. They are the Oak Ridge School of Reactor Technology and the International School for Nuclear Science and Industry at Argonne. Fellowships are provided by the Commission at several universities for the study of radiological physics, industrial hygiene, and industrial medicine.

Furthermore, the Commission extends assistance to educational institutions that they may acquire research reactors and subcritical assemblies which are highly useful training tools. Nuclear materials and byproducts are available for educational purposes, as well as many teaching aids, laboratory apparatus, and demonstration equipment.

All these are provided by means of Commission grants and contributions. I think the education editor of the New York Times, Dr. Benjamin Fine, will be as surprised as I was by Dr. Parsegian's astonishing statement that this is hampering the training of scientists and engineers.

Dr. Parsegian, in his article, discusses at some length the procedures followed in granting access to classified information and seems to imply that the Commission imposes a hardship on colleges and universities, particularly because of certain charges which are sometimes made to cover the costs of the process. In saying that Rensselaer Polytechnic Institute must pay from $15 to $265 each for such clearances, he neglects to mention that the Institute is already well represented on the rolls of cleared individuals—and without cost.

R. P. I. was granted 25 "Q" clearances by the Commission without charge, as is customary. The $265 fee of which he speaks applies only to clearances in excess of 25 and represents the cost of the procedure to the Government. The sums go to the Treasury, not to the AEC. The charge does serve as a deterrent to requests for unnecessary clearances.

The Atomic Energy Commission, since it administers a new and rapidly expanding enterprise of research and development—an enterprise for which no precedent exists—is not inhospitable to criticism. Indeed, it welcomes constructive criticism and suggestions for the improvement of its operations.

It is for this reason that the AEC relies more strongly perhaps than any other agency of Government on the help of its various advisory committees. These include representatives from many of the Nation's foremost educational institutions. I have never heard them raise the points made by Dr. Parsegian in his article. Criticism and complaints, if they are to be constructive and help us improve our program, ought to be based on familiarity with the program and on the facts.

Representative PRICE. You have been and may be the only representative of universities who has formally stated this position before this committee, but I certainly have heard many, many times through recent years some representatives of the different universities who have, although not officially, so stated such a position.

Representative HOLIFIELD. It seems to me, Doctor, if we get into this field of the widespread building of reactors and access permits to all of the skills and techniques, and so forth, and the support of the reactors, we might as well start growing up and realizing that we shall not keep anything in the reactor field a secret.

Mr. PARSEGIAN. Yes, sir.

Representative HOLIFIELD. If we train people to operate these reactors and send them into every country in the world, practically every technique in the field will be known.

Mr. PARSEGIAN. Yes, sir.

Representative HOLIFIELD. I am very much impressed by the position that you are taking here this morning in this particular field, still excluding the applications and designs of weapons, and so forth, excluding that to one side. I am very much impressed by your position.

Representative PRICE. Doctor, may I say, I have heard it not only from you but from others representing universities before, and I have heard it from important sources close to the reactor program. There are many who feel as you do.

The CHAIRMAN. Senator Dworshak.

Senator DWORSHAK. No questions.

The CHAIRMAN. Mr. Van Zandt.

Representative VAN ZANDT. To accomplish what you have in mind would necessitate an amendment to the Atomic Energy Act of 1954, would it not?

Mr. PARSEGIAN. I think so.

Representative VAN ZANDT. Then the responsibility rests with this committee.

Mr. PARSEGIAN. Yes, sir.

Representative VAN ZANDT. Thank you.

The CHAIRMAN. Mr. Jenkins.

Representative JENKINS. No questions.

The CHAIRMAN. Mr. Patterson?

Representative PATTERSON. No questions.

Representative COLE. How would you propose changing the law, Doctor, to accomplish what you want?

Mr. PARSEGIAN. That requires going into details. But I do believe that from the very first there should be a more positive paragraph added to the statements which we now have in the "Declarations, Findings and Purpose." These are fine as they stand, provided they do have, in addition, recognition of the present state of affairs and the need for a positive approach to this problem of atomic reactors. Then, following a statement of that sort, there are a number of places where minor changes might be put in here and there in the spirit of that modification, and probably some major changes in the patent section.

Representative COLE. Do you not agree that the production of special nuclear materials is an element of the program which has a vital bearing on our national security?

Mr. PARSEGIAN. I consider that that program is now vital only to the degree that it is part of our industrial economy. We have passed the point, I believe, where more bombs are the answer. I believe now we have reached the point where better reactor systems and integrating the atom into our industrial life should be the main objective.

Representative COLE. This doesn't refer to the volume of production of special material. It relates to all aspects of the production of special nuclear material.

Mr. PARSEGIAN. I would hate to have us think that our defense simply rested on more production of more fissionable material. I think we have passed the state where the amount of fissionable materials available for weapons is the main objective.

Representative COLE. This is not related to volume of production. It is related to methods and refinements of production, which in my opinion relates very directly to national security. Under our conception as I see it you would declassify all aspects relating to reactors.

Mr. PARSEGIAN. Yes, sir.

Representative COLE. Even including military reactors such as the submarine reactor and the aircraft reactor—all reactors.

Mr. PARSEGIAN. No. Just to avoid argument, I would keep out design of the submarine reactor, design of the aircraft reactor, and of such special problems as are unique to those systems. But when it comes to materials development, and basic problems of heat transfer, which are the main "guts" of the industrial atomic program, I would say, sir, that our loss would be most serious if those were withheld from industry.

Representative COLE. I would be subject to correction but I would almost wager that those aspects are not classified now.

Mr. PARSEGIAN. I must differ on that, sir.

Representative COLE. You probably are right, then.

Representative VAN ZANDT. Doctor, are you familiar with the experimental research reactor, the swimming-pool type on the campus of Pennsylvania State University?

Mr. PARSEGIAN. Yes, sir.

Representative VAN ZANDT. What would you do, knock down the fence that surrounds that reactor?

Mr. PARSEGIAN. There is no fence around that reactor as it is now.

Representative VAN ZANDT. The fence is for protection of the people.

Mr. PARSEGIAN. For safeguard; yes.

Representative VAN ZANDT. That is right.

Mr. PARSEGIAN. The problem is not those research reactors. The problem is not in connection with the reactor that was described earlier this morning. The problem has to do with the power reactors. As Mr. Smythe mentioned in an article, the technical problems that go with power reactors are a factor 100 times more serious, as the cost is greater in the power reactors as compared with the research reactors. Our effort must be not exclusively on research reactors but on the materials reactors, and on problems connected with power reactors.

The CHAIRMAN. Thank you very much, Mr. Parsegian. We appreciate your testimony.

The next witness this morning is Dr. Shapiro, Nuclear Materials & Equipment Corp., Pittsburgh, Pa.

Doctor, will you come around, please.

Good morning, Doctor. We are glad to have you with us this morning. Do you have a prepared statement?

STATEMENT OF ZALMAN M. SHAPIRO, NUCLEAR MATERIALS & EQUIPMENT CORP., PITTSBURGH, PA.

Mr. SHAPIRO. Yes, I have.

The CHAIRMAN. You may proceed.

Representative COLE. Mr. Chairman, may I ask the Doctor to give us a bit of his background in this field so we can have some idea of his experience.

Mr. SHAPIRO. Yes.

Mr. Chairman, I am Dr. Zalman Shapiro, president of the Nuclear Materials & Equipment Corp., a new company to be located at Apollo, Pa., a town some 30 miles northeast of Pittsburgh. My company is about to engage in the manufacture of fuel and control rod materials and associated equipment. In addition, we shall recover fuel and control rod scrap for the industry and provide research and development services in chemistry and metallurgy for the atomic-energy program.

Prior to the formation of my company, I was associated from its inception with the Bettis Atomic Powerplant, which is operated for the AEC by the Westinghouse Electric Corp., and was privileged to participate in great measure in the materials development and design of such projects as the *Nautilus* and the PWR.

The committee is to be commended for selecting materials problems as a principal topic for these hearings, for I believe that there is no subject quite as germane to the development, state, and growth of the atomic-energy program. Unless today's materials problems are expeditiously solved, the power reactors presently scheduled for construction in the United States will be delayed. This is a challenge to companies such as ours, and given the opportunity, I am confident that the challenge will be met.

First, I would like to discuss materials problems from the broad point of view.

New fields of technology generally demand new materials. When metal bridges were first built, cast iron was used as a material of construction. But its properties proved so restrictive that its application was limited. Such engineering wonders as the Golden Gate Bridge were only made possible by the development of high-strength steels. Similarly, the incandescent electric-light bulb would emit a feeble light with a carbon filament, but efficient use was not realized until the tungsten filament was developed.

We are not in the cast-iron age and carbon-filament stage of atomic energy. What makes materials problems in nuclear reactors particularly severe are the most excruciating performance requirements, demanding extraordinary resistance to combinations of stresses, high temperatures and corrosive environments, and all of these must be provided for within a neutron flux which, in itself, severely modifies all properties of any known material of construction.

Never before have designers required such rigorous performance and close tolerances under such adverse conditions, and never before have metallurgists, materials engineers, chemists and solid state physicists worked so hard to come up with a solution to these problems. It is of particular credit to Admiral Rickover and the men engaged in the naval-reactors program, as well as to the men at Argonne and other AEC installations, that despite all of this we have any operating power reactors today.

I would like to present some of the more critical problems and briefly discuss their effect on reactor performance.

CLADDING MATERIALS

As you know, all but homogeneous reactors have solid fuel elements. These are usually jacketed with some material in order to prevent the escape of fission products into the system. The cladding or jacketing material must meet criteria which often seem to be at cross purposes, for the cladding must not absorb neutrons. Yet it must, at the same time, be compatible with the fuel, be corrosion resistant in the presence of the coolant, transfer heat readily, possess good fabricability and meet a host of other requirements. Today's cladding materials are usually zirconium, aluminum, and stainless steel. English power reactors use magnesium. Each of these has its own deficiences; I shall list but a few.

Zirconium, in addition to being expensive, corrodes at the higher temperatures where water-cooled reactors would become highly efficient. Aluminum, while considerably less expensive, loses its strength and corrosion resistance at even the current moderate power reactor temperatures. Stainless steel, although strong and corrosion resistant

at the temperatures at which zirconium and aluminum fail, wastes neutrons and therefore requires a higher investment of fuel, which in turn creates a control problem. Magnesium is useless for any currently scheduled American power reactors.

Representative HOLIFIELD. That last sentence reads: "Magnesium is useless for any currently scheduled American power reactors." Why do you make that statement?

Mr. SHAPIRO. Our current power reactors, that is, our currently scheduled power reactors, are not carbon-dioxide-cooled reactors. Magnesium, particularly the Magnox which is used in the English power reactor, is particularly suitable for a gas-cooled reactor.

Representative VAN ZANDT. What did you mention was used?

Mr. SHAPIRO. Carbon dioxide.

Representative HOLIFIELD. If we did go into the development of the gas-cooled reactor we might be forced to utilize magnesium, the methods which the English have developed.

Mr. SHAPIRO. To an extent, yes, but I would feel that there are better materials which certainly could be used in connection with these reactors. Magnesium is a cheap material but it does have many disadvantages.

Representative PRICE. How satisfactory is it in the British use?

Mr. SHAPIRO. It is satisfactory enough for the initial, let us say, model T. However, if they wish to raise the temperatures, if they wish to operate under more severe conditions, if they want a more efficient reactor, I think eventually they will have to go to other materials.

Representative HOLIFIELD. Do we have any knowledge as to whether the Russians are using magnesium in that 5,000-kilowatt reactor which they showed pictures of at Geneva?

Mr. SHAPIRO. I don't think they would be using magnesium in that connection because it would not be corrosion resistant. I believe that the Russian reactor to which you are referring is a water-cooled reactor.

FUEL MATERIALS

Next I would like to describe some of the limitations of our present fuel materials.

Since the cost of highly enriched uranium is so prohibitive, and since it is unattractive in the foreign market, power reactors fueled with natural or only slightly enriched uranium are most desirable. It is impractical, however, to use pure uranium. Because it undergoes severe dimensional changes under even moderate radiation and disintegrates in the presence of water even at intermediate temperatures, it must be alloyed. The problem of metallic uranium fuel is therefore one of finding an alloy of uranium which has the least possible amount of modifying materials and still meets design requirements. The use of natural and slightly enriched uranium oxide is being attempted today to circumvent some of the difficulties, but unfortunately it must be used in a type of fuel element which has relatively poor heat transfer properties. The resulting inefficiency means bigger reactors and higher costs.

Senator GORE. Doctor, I would like to ask a question there. You wouldn't stand flatfootedly on the statement, would you, that the

cost of 235-uranium, though quite expensive now, could not be brought within the realm of economic fuel?

Mr. SHAPIRO. No; I would not. I am basing this on current technology.

Thorium, which is contemplated as a fuel blanket material in pure form, corrodes so badly in the presence of water that its use in water-cooled reactors without modification can hardly be recommended.

Plutonium is a fuel material which will be available in increasing abundance as soon as sufficient quantities can be spared from our military requirements and power reactors begin producing it for later recycling as fuel. Utilization of plutonium as a fuel is essential to the achievement of economical nuclear power. However, despite the promise of great economies by breeding our fuel in reactors rather than separating U–235, pure plutonium as a fuel is a "chamber of horrors." Even vanishingly small quantities of plutonium in the air of a fabricating shop can seriously poison employees. Furthermore, fuel elements utilizing plutonium become severely distorted when passing through even gradual and low temperature changes. So much for fuels.

Senator GORE. You mean the material itself?

Mr. SHAPIRO. Yes; the material itself. Technically speaking, it goes through a number of phase changes, and during each one of these phase changes the properties of the material alters. For example, the coefficient of expansion, that is, the amount that a material will expand at various temperatures, will alter as it goes from one phase to another, and so on. Other properties vary. There is a terrific amount of instability caused by the variations in the properties that this material goes through as it goes through the various phases.

Senator GORE. Do you or do you not mean to suggest that there is some actual molecular change in the nature of the material itself?

Mr. SHAPIRO. Yes; there is a structural change as it goes through the various phases. That is, the atoms are arranged in a particular array. When it goes through a phase change the array in which the atoms are arranged changes. During this change the properties of the material will alter.

Senator GORE. This same thing might occur, might it not, as a result of intense magnetic fields?

Mr. SHAPIRO. I don't think I am qualified to answer that point, particularly in the case of plutonium.

CONTROL MATERIALS

The next group of materials I would like to discuss are control materials, an equally important component of reactors.

At the moment the only proven material for the control of water-cooled reactors is hafnium. The element hafnium is a byproduct of the processing of reactor grade zirconium and is only present on the average in 2 parts per hundred in natural zirconium. Consequently, it is available only in limited quantities. However, in a reactor the ratio of hafnium to zirconium is approximately 1 to 10. Thus, in any such reactor, approximately 5 times as much hafnium would be needed than could possibly be obtained from the zirconium going into the same reactor.

Theoretically the element would be an excellent replacement for hafnium because of its neutron absorption qualities, but unfortunately it generates gasses when irradiated and becomes dimensionally unstable.

Many other exotic materials with tongue-twisting names have been suggested as a replacement for hafnium and some of them have been tried. But nothing yet has been found to equal hafnium.

CORROSION PROBLEM

In the coolant and heat-exchanger system there are also materials problems which should be mentioned. Some of them have been recently dramatized by the difficulties encountered in the *Sea Wolf* and the HRE–2 at Oak Ridge. Here the main problems were probably caustic embrittlement and stress corrosion. A less publicized but equally serious corrosion problem of the primary system of water cooled reactors is the deposition on irradiated surfaces of a sludge known as "crud" in the trade. This could cause fuel-element failure and serious contamination of the system. Similar equally severe problems exist in liquid metal and other coolant systems.

The materials of which I have spoken are expensive. Yet, in some fabrication operations scrap losses are often as high as 50 percent. In the economics of any industry such losses are prohibitive. In addition, scrap presents serious safety hazards during storage. Economic methods must be found to reclaim and recycle these materials.

In order to achieve economic nuclear power, it is not only necessary to reduce the initial cost of the reactor and increase its power output and lifetime, but, because the reactor represents only about 10 percent of the cost of the plant, it is necessary to effect major reductions in the cost of the plant as well. The assurance of complete reliability of the core and the primary system would enable the elimination or simplifiction of many of the costly safety features which must be provided today. Thus, quality and high reliability are attributes well worth fighting for.

Despite the gloomy picture I have presented, tremendous strides have been made, particularly in the naval reactors program. This is indeed a great tribute to American industry and science.

For the future, it is our considered opinion that it is not in the best interests of the development of economical nuclear power to attack materials problems concurrently with the design and construction of power reactors, although this has been a necessary condition because of the urgency of the program. For the attainment of truly econmic power, the materials problem must be anticipated and solved prior to the detailed design and construction of the reactors themselves. It is here that small business can make great contributions. We do not believe it is feasible for small business to attempt to build complete nuclear-power plants. Because of the immense resources needed for the construction of such plants, this necessarily falls within the capabilities which only large industries possess. Small business, however, can make an essential contribution not only in the areas of research, development, and service, but also in the fields of production and supply of materials and components. Our company, for example, has assembled a nucleus of highly experienced specialists in the nuclear-materials field. Because we are not beset with the

day-to-day problems associated with the design and construction of a particular reactor, we are in a position to devote our efforts to the solution of the general materials problems necessary for economic nuclear power. Our services are available to the total industry rather than being concentrated on one project. I am sure there are other companies similarly constituted.

In closing, I would observe that it was with great wisdom that Congress incorporated the section 202 hearings into the Atomic Energy Act of 1954, thus providing industrial participants with an annual forum for the discussion of our mutual problems. The partnership of the committee, the AEC, and industry engendered by the spirit of these discussions will assure the continued leadership of the United States in the peaceful uses of atomic energy.

I thank you, Mr. Chairman and members of the committee, for the opportunity to appear here today.

The CHAIRMAN. Thank you, Doctor.

Doctor, are you a metallurgist by profession?

Mr. SHAPIRO. I was trained as a chemist. However, a great amount of my work was in the metallurgical field.

The CHAIRMAN. I notice in your discussion here that you mention a few materials, one of which, of course, is high temperature resistant, hafnium, but you didn't mention any of the other groups of high temperature resistant material such as molybdenum, asbestos, tungsten, and many others.

In other words, do you think the materials problem can be solved by the heat-resistant metals or do you think we shall have to go to some type of ceramics or some other alloys? I know it poses a problem because of the fact that we are now reaching very, very high temperatures with the systems we are trying to develop, not only in the field of airplanes but in other lines.

Mr. SHAPIRO. We have a number of different types of reactors under development today. Each one of these demands materials suited for its own particular purpose. The water-cooled reactors demand a material, for example, for the cladding which must be corrosion resistant, have good heat-transfer properties, and so on, and must have at the same time low neutron-absorption cross sections.

The CHAIRMAN. In the atomic table of elements you have just about 94 with which to do all these things. Of course, you have developed some minor elements through the atomic-energy program, but we still have to depend on the elements like these resistant to high temperatures to try to do this job.

Mr. SHAPIRO. Yes; that is true. On the other hand, we have a limited number of elements that we can actually employ in these reactors because we have to take into account all of the properties of the materials with which we deal. For example, we could not use tungsten very well in the core proper, because of its high neutron-absorption cross section.

The CHAIRMAN. That is true, but its temperature resistance is up around 6,000.

Mr. SHAPIRO. It has a high melting point, Mr. Chairman, but it oxidizes very easily. For example, we could just not use tungsten unprotected in an air-cooled system.

The CHAIRMAN. Without alloying it with some other metal?

Mr. SHAPIRO. Without its being alloyed or protected in some manner.

The CHAIRMAN. You are evidently experienced in this business. Do you think there is enough interest in this country to try to solve this problem? I notice on the list you are the only man so far who seems to be interested in this materials division. I think one of the greatest problems we have is to extend temperatures out to the point where they will produce what we desire in propulsion systems.

Mr. SHAPIRO. The materials problem is a very serious problem, and I think it really poses the severest limitation on our reactor design.

The CHAIRMAN. Would you say it is a bottleneck?

Mr. SHAPIRO. It certainly is in a number of cases, without question.

The CHAIRMAN. I think I agree with you.

Mr. SHAPIRO. The materials problem has to be attacked very, very strenuously. It is being attacked very strenuously. However——

The CHAIRMAN. Do you think on a broad enough base?

Mr. SHAPIRO. I believe this is where the problem is. We have, I think, two types of attacks on the materials problem. One is the very basic attack which is being carried on at universities for the Atomic Energy Commission. We have the practical attack which is being carried on at the installations interested in the particular reactors which they are building. Consequently, the attack on the materials problem is aimed at the specific reactors being constructed for the most part, that is, the developmental aspects of the materials problem are aimed at the specific problems of that particular reactor. What we need for the future is a broader attack on the materials problem, so if a reactor type is conceived which requires a different material, we can go to our source of information and say to ourselves, "Yes; we have such a material," or "we have investigated the problems associated with such a type of reactor, and we find that such a reactor is either practical or impractical."

The CHAIRMAN. I think you probably know that at the present time we are trying to control thermonuclear heat, and we are having difficulty with this heat that we are trying to harness for power purposes at the present time. When you think of the difference in the temperatures and the metals we have to hold these temperatures, it poses a very difficult problem, in my opinion.

Mr. SHAPIRO. Yes; it does, indeed.

The CHAIRMAN. Do you know of anybody else in the field that you are in at the present time, just building materials primarily for the control of fission?

Mr. SHAPIRO. Most of the atomic-energy installations concerned with the construction of reactors——

The CHAIRMAN. I don't mean that program. You are a private enterprise man, as I understand it.

Mr. SHAPIRO. As far as I know, there are no other private outfits concerned with the construction of materials for control rods.

Representative VAN ZANDT. Do you specialize in this field?

Mr. SHAPIRO. Yes; not only in control materials but also in reactor materials in general.

Representative VAN ZANDT. Isn't it true that there are others who specialize in this field?

Mr. SHAPIRO. Yes.

Representative VAN ZANDT. And part of their overall objective is this specialized work which you perform?

Mr. SHAPIRO. Yes, indeed. Reactor materials.

Representative VAN ZANDT. Doctor, inasmuch as you were identified with the Atomic Energy Commission and now you are identified with private industry, I am wondering if you have any recommendations as to how the Atomic Energy Commission may expand its program to help overcome this problem which you are discussing.

Mr. SHAPIRO. I believe so. My experience in working at Bettis has been that we have been so consumed with the day-to-day problems, with the solution of the materials problems associated with the particular reactor that we were working on at the time, that we had very little opportunity, if any, to work on the materials fields surrounding the particular reactor that we have. We have done a great many engineering tests which are extremely expensive, which are required in order to design and construct these reactors. However, they are of a limited nature and related to the particular reactor. What we need is a broadening of the base of the work.

Representative VAN ZANDT. Would you say this represents a bottleneck today?

Mr. SHAPIRO. Yes, I think so, a very serious one.

Representative VAN ZANDT. Where could this committee suggest to the Atomic Energy Commission that we broaden this existing program to overcome this bottleneck?

Mr. SHAPIRO. I think the problem really goes down to one of finances. I believe that the committee, as well as the Commission, must recognize the terribly expensive nature of materials development work and consequently in its budget must provide more money than has been provided in the past for work of this particular nature, to enable installations of the Atomic Energy Commission to look ahead some years in the future rather than to stick strictly to the problem at hand.

To illustrate this, in connection with one of the programs of Bettis it was necessary to do a critical experiment, that is, an experiment to indicate whether a reactor of a particular design will perform adequately from the nuclear standpoint. In order to do this, it is necessary to build almost a full-scale mockup. The cost of this mockup was underestimated by some $4 million. It was not because the people at Bettis are inexperienced. It was not because they had not estimated properly. It was simply because of the problems which were encountered in the construction which were not previously anticipated.

Representative VAN ZANDT. One more question, Mr. Chairman, please.

Doctor, how attractive to business in general in the Pittsburgh area has the offer of your services been?

Mr. SHAPIRO. We are a brandnew company and are just entering into this field. I think our services will be attractive. There are certain barriers which must be overcome in connection with our services. The fact, for example, that I left Bettis Field and was associated with the effort there.

Representative VAN ZANDT. What are the barriers you have in mind?

Mr. SHAPIRO. The fact that I have been associated with Bettis Field and was employed there and know many of the people there makes them feel that they should bend over backward. For example, in talking with us with regard to their problems, they feel that they may be accused of favoritism in connection with giving us any sort of work. I think I can see the point. On the other hand, we would like to be looked upon as any other vendor would be looked upon, and not be discriminated against, not because they particularly want to but simply because they are afraid that any contract which would go to us would put them in a very unfavorable light, you see.

These are the types of things that we must overcome.

Representative VAN ZANDT. In other words, to date, your prior employment with the AEC at Bettis Field is a handicap?

Mr. SHAPIRO. It really is a handicap in spite of the fact that we have much to offer to Bettis and to other installations of this type by virtue of our experience and the fact that we have gotten together a group of people who are very great experts in the particular field in which we intend to engage.

Representative VAN ZANDT. Thank you.

The CHAIRMAN. Mr. Cole.

Representative COLE. I don't think you quite mean that your employment at Bettis has been in balance a handicap?

Mr. SHAPIRO. No. Actually——

Representative COLE. It has been greatly advantageous, as you hoped it might have been?

Mr. SHAPIRO. It really has been great help. The experience that I have gotten at Bettis has been a tremendous asset. From the standpoint of getting business, however, it is disadvantageous to a degree.

Representative COLE. When you speak of bending over backward, the direction of that bending is not in your direction?

Mr. SHAPIRO. That is right.

Representative COLE. They are making every effort to avoid a charge of favoritism?

Mr. SHAPIRO. That is right. I can understand the attitude certainly.

Senator DWORSHAK. One question, Doctor: In the development of reactor material do you know whether we have the potential domestic production of the minerals which will be necessary or do we have to rely generally on foreign sources?

Mr. SHAPIRO. To my knowledge, aside from our uranium resources with which you are familiar, I think our resources of materials are quite adequate. One of the problems that was encountered recently concerned niobium metal, which is being contemplated for use. This was a material which was short and yet I believe it is felt now that this material is in abundant supply. There may be other materials as we progress with our materials development program that may come up of which we do not have an abundant supply. However, at the moment we are in good shape.

Senator DWORSHAK. Most of these were not required until we had the development of atomic energy. Notwithstanding that, you think within this country we have potential deposits of reserves which can be developed?

Mr. SHAPIRO. Yes, I think so.

The CHAIRMAN. Do you believe that applies to rare earths?

Mr. SHAPIRO. Yes. We have uncovered rather large deposits of rare earths in this country.

The CHAIRMAN. Some of them have a very high temperature resistance?

Mr. SHAPIRO. Some of them have excellent properties.

The CHAIRMAN. Any further questions?

Representative VAN ZANDT. Doctor, how many contracts do you have at the present time?

Mr. SHAPIRO. We have zero.

The CHAIRMAN. With the Government?

Mr. SHAPIRO. With the Government, at the moment, we have zero contracts. All of our money is going out.

Representative HOLIFIELD. Doctor, do you know of any AEC program for the development of control rods outside of the hafnium effort?

Mr. SHAPIRO. Oh, yes. There is an extensive program for the development of alternate control rods sponsored by the Atomic Energy Commission. However, the sad part is that as far as I know only one material, one alloy, at least at the moment, seems to be suitable as a possible replacement for hafnium. We are not sure of this, even, by virtue of the fact that we have not completed irradiation tests on this material. A tremendous amount of effort was put into the utilization of boron as a control material, and the application of this in many forms has been attempted, but I don't think that this has yielded anything of great importance.

Representative HOLIFIELD. Do you think that the Atomic Energy Commission's program should be widened in scope, probably in their own laboratories and also in research contracts with private industries such as yours?

Mr. SHAPIRO. Yes, indeed.

Representative HOLIFIELD. Is there capability of doing research in this field that they are not now exploring?

Mr. SHAPIRO. Yes, I believe so. I believe there is a great capability of doing research on things which are not being explored now, as well as in broadening the aspects of those things which are being explored.

Representative HOLIFIELD. I understand that thorium was abandoned recently by Consolidated Edison for their reactor.

Mr. SHAPIRO. Yes. (See relevant corespondence, p. 202.)

Representative HOLIFIELD. What do you think of the future of thorium as a fuel?

Mr. SHAPIRO. Thorium is being used in other applications as well. In the case of the Consolidated Edison plant, thorium was used or it was intended that thorium be jacketed, that it be protected from the system. This caused difficulties. Thorium is being contemplated for use in the Pennsylvania Power & Light reactor. It is contemplated for use in the homogeneous reactor as a blanket material, in the HRE–2 and so on. So thorium as a fuel material has potentialities. However, each particular reactor has its own problems, and they are quite serious. Each one of these, as you know, is encountering materials difficulties in connection with its use.

Representative HOLIFIELD. I don't know of any reactor project where the flow of materials, and so forth, has been completely developed prior to the design of the reactor. Maybe this is a necessity

in view of the state of the art. Any of these reactors that are now proposed, particularly the large ones, depend upon the concurrent development of materials, do they not?

Mr. SHAPIRO. Yes, they do. To a large degree this is terribly expensive and time-consuming and wasteful.

Representative HOLIFIELD. If the materials failed, for instance, isn't it true that the whole investment to a certain extent is jeopardized?

Mr. SHAPIRO. That is true. It means that the reactors which are under design must be designed in a very flexible manner so you can accommodate changes in materials, changes in fuel elements, for example.

Representative HOLIFIELD. We are faced with the corrosion problem in all the sodium-type reactors.

Mr. SHAPIRO. Yes, we certainly are.

Representative HOLIFIELD. The *Sea Wolf* reactor is finished and operating, and yet we are faced with this corrosion problem, which seems to indicate that it may be necessary even to pull the plant and put in a different type of plant.

Mr. SHAPIRO. That is possible. However, I am sure with the development of the technology, that even plants such as this will be practical. The fact of the matter is that tomes have been written about stress corrosion and caustic embrittlement. Nevertheless, we understand very little about this corrosion, and what we need is some additional research and development work.

Representative HOLIFIELD. Can we afford to wait for the proving of materials and withhold our reactor development, or is it almost necessary at this time because of the state of the art and the urgency of development, that we do proceed by the concurrent method which we are using?

Mr. SHAPIRO. Yes, I believe that is right. However, I believe too that the stage is now reached where we must start thinking ahead and providing for work ahead so this tremendous waste which is associated with the work, because of the urgency of the problem, can be eliminated to a large degree.

Representative HOLIFIELD. What you are really plugging for at this time is that there be a greatly enlarged program in the materials-testing field?

Mr. SHAPIRO. Yes, in the materials-development field in general.

Representative HOLIFIELD. Research and development field.

Mr. SHAPIRO. That is right.

The CHAIRMAN. Any further questions?

Thank you very much, Doctor. We appreciate your presentation.

The committee is in recess until 2 o'clock this afternoon.

(The letter referred to on p. 201, follows:)

THE BABCOCK & WILCOX CO.,
ATOMIC ENERGY DIVISION,
New York, N. Y., March 13, 1957.

Hon. CARL T. DURHAM,
Chairman, Joint Committee on Atomic Energy,
Washington, D. C.

DEAR MR. CHAIRMAN: During the hearings before the Joint Committee on Atomic Energy on February 20, 1957, Representative Holifield directed questions to Mr. Z. M. Shapiro, of the Nuclear Materials & Equipment Corp., relating to the application of thorium in nuclear power reactors.

The following quotation is taken from a stenographic transcript of the hearings by Alderson and Veley:

"Representative HOLIFIELD. I understand that thorium was abandoned recently by Consolidated Edison for their reactor.

"Mr. SHAPIRO. Yes."

This exchange of statements was not further developed and leads one to believe that the application and utilization of thorium as a fertile material, one of the basic objectives of the Consolidated Edison project, is no longer considered of interest.

Actually, the Consolidated Edison Co., on the advice of the Babcock & Wilcox Co. technical staff, has decided to use thorium oxide rather than thorium metal in the fuel elements of the first core for the reactor. This we are sure is the change to which Messrs. Holifield and Shapiro made reference.

You will recall Mr. H. R. Searing, chairman of the board, Consolidated Edison Co., wrote the joint committee on February 13, 1957, with regard to the progress made by his company on the Indian Point station. In his letter, Mr. Searing reported the fact that the reference fuel material had been changed to thorium oxide and outlined briefly the reasoning behind the change.

Thus Consolidated Edison and the Babcock & Wilcox Co. continue to pursue with much interest and vigor the potentialities of thorium and thorium materials for power reactors.

We would appreciate very much if the final published record of the hearings could be corrected to show more exactly the situation as it now exists.

Respectfully yours,

FRANK R. WARD,
Project Manager, Consolidated Edison Thorium Reactor Project.

(Whereupon, at 12:05 p. m., the committee was recessed, to reconvene at 2 p. m., the same day.)

AFTERNOON SESSION

Senator GORE (presiding). The Joint Committee will come to order.

The first witness for this afternoon's session will be Dr. Chauncey Starr, general manager of Atomics International Division, and vice president of North American Aviation, Inc.

The committee is pleased to have you here with us, Dr. Starr.

STATEMENT OF DR. CHAUNCEY STARR, GENERAL MANAGER OF ATOMICS INTERNATIONAL DIVISION, AND VICE PRESIDENT OF NORTH AMERICAN AVIATION, INC.

Dr. STARR. The development of atomic powerplants for peaceful purposes has moved during the last decade from conceptual studies to the actual construction and operation of experimental plants. The widespread interest and activity in this field of development is a measure of the statesmanship and long-range planning of both this committee and the Atomic Energy Commission. Because of the ponderous and costly nature of the experimental development involved, the technological growth of the atomic-power field would necessarily have been extremely slow without such support.

The present reactor programs being undertaken by the Atomic Energy Commission and private industry represent a widespread approach to the development of atomic powerplants whose operation may be both reliable and economically desirable. Although much progress has been made along these lines, it is important to recognize that as yet, neither of these two practical goals has been demonstrated for an electrical generating plant. It is, therefore, likely that many

years, perhaps 5 to 10, of continued development effort and operating experience will be required before the tangible criteria of reliability and cost competition with conventional fuels may be met.

FOREIGN MARKET REQUIRES PROGRAM ACCELERATION

It has become evident during the past years that the intangible values associated with atomic power may in certain instances be more important than the tangible economic factors. Atomic power has become an instrument of international relations.

It has captured the imagination of peoples throughout the world and has become a symbol of progress and of future bounty. In addition, there are particular situations where the availability of power under adverse international circumstances is of greater importance than the economic cost of such power.

Senator GORE. Are you referring to such a situation as prevails in Western Europe?

Dr. STARR. Yes.

Senator GORE. Doctor, were it not for the fact that atomic power has now become, as you say, "an instrument of international relations," the urgency for its development in this country would not be nearly so acute.

Dr. STARR. I believe that is correct.

Senator GORE. You agree with that?

Dr. STARR. Yes.

Furthermore, the foreign market for nuclear reactors will probably appear at an earlier date than the market in the United States, because of the higher cost of conventional electrical power and the shortage of fuels in many foreign countries.

Such factors have resulted in a stimulation of the foreign market for atomic power to an extent which presently strains the existing technology of the atomic energy industry. For these reasons, it is increasingly important that the experimental development of atomic powerplants be appropriately accelerated.

ENRICHED NUCLEAR FUEL SUITABLE FOR DOMESTIC AND FOREIGN REACTORS

The direction of the United States programs should be critically examined with regard to the industrial and governmental relationships which will exist both within individual countries and between nations.

In this connection, the absence, so far, of a free-world market in enriched uranium, as contrasted to natural uranium has resulted in a concentration of interest by many foreign countries in natural-uranium reactors. However, the programs which have received the emphasis in the United States have been those which appear most promising for eventual competition with conventional fueled plants in this country, without regard to uranium enrichment. The technical results of the several enriched uranium reactor programs continue to support the soundness of this course.

It is also of importance that the economics of small powerplants benefit from the use of enriched fuel. Such plants are of particular value in isolated locations, as, for example, mining communities, and in many similar parts of the world where large central-station powerplants cannot yet play a role.

It has become evident that the choice of natural uranium versus enriched reactors, the choice of reactor type, and the long-term development of an atomic energy complex is closely associated with the availability of different types of fuels, the availability of the supporting fuel reprocessing systems, and the geopolitical relationship of the atomic powerplants and these supporting systems.

In this regard, it should be mentioned that many nations of the world are dependent upon imported conventional fuels and that the economic factors in the development of atomic power may similarly warrant the importation of enriched fuels at such time as a free and dependable market may exist.

Senator GORE. In connection with that thought, I would like to suggest the possibility of a parallel. I heard Secretary Dulles testifying before the Foreign Relations Committee of the Senate. In response to a question from Senator Johnson of Texas as to why it was necessary and urgent for the Congress to pass a resolution endorsing the Eisenhower doctrine in the Middle East, he responded by pointing out that two-thirds of the world's oil resources, the known resources, were to be found in the Middle East.

He stated that the industrial economy and society of Western Europe was dependent upon that source for its oil supply. Without that oil it could not remain an industrial society.

Therefore, if Russia gained control of the oil resources of the Middle East, Russia could indirectly, but effectively, gain domination and control of Western Europe without firing a shot.

Now, in view of the paragraph you have just read, would you say that oil resources and dependence of one nation upon another for sources of its energy with respect to oil would be somewhat parallel 20 years from now or 10 years from now, with respect to one nation being dependent upon another for its source of energy from atomic sources?

Dr. STARR. I think the parallel is one of degree. If a foreign country were to depend upon the United States or any other source for enriched uranium, it is to be expected that such sources are going to be few because of the enrichment plants required to produce it. The difficulties which might arise by the interference with the importation of these fuels do not create an immediate urgency as they do in the case of oil or conventional fuels.

Power reactors are refueled in cycles that number in terms of years rather than in terms of days or weeks. It is possible for a country to operate its nuclear powerplants for a considerable length of time, perhaps as much as a year or so, without continued importation of enriched fuel.

While there is a problem of degree in the similarity between importing enriched fuel and the importing of oil, the time element, instead of being one of weeks, is one of years. In this sense I think it would be more acceptable to a foreign nation to depend upon an enriched fuel supply from outside its boundaries.

Senator GORE. I accept your qualification, but in the final analysis would not the dependence of one nation upon another for its source of energy, whether from fossil or fissionable fuels, tend to establish a friendly and cooperative relationship between those two nations?

Dr. STARR. Well, I think it would certainly establish an area of interdependence, which ought to assist in establishing friendly relations between nations.

Senator GORE. Do you not think that it would be in the interests of the United States to establish interdependence with nations of Europe, Asia, and Africa rather than to while away its time and permit that interdependent relationship to be established between those countries and the Soviet Union?

Dr. STARR. I agree completely with this thought, Senator, and the thesis I was trying to establish here was that in spite of the remoteness of these foreign countries, the importation of enriched fuel which would have to be done either from the United States or from England——

Senator GORE. Or the Soviet Union.

Dr. STARR. Yes, that this importation of enriched fuel is not as limiting a restriction upon the freedom of action of these foreign countries as one has been led to believe by general statements.

Senator GORE. Instead of having a few weeks to arrange for a new source of oil supply, they would have perhaps a matter of 1 to 2 years in the case of enriched fissionable fuel?

Dr. STARR. Yes, that is correct.

Senator GORE. But the essential facts vis-a-vis economic and political friendship and relationship are essentially the same.

Dr. STARR. Yes, and I think in addition there is this other factor that those countries that have had a free choice of reactor development, where the choice has been made not on the basis of whether the fuel is available, but on the basis of what direction they wish to go for making the most economical power over the long term, chose the enriched fuel route.

I think we would be doing a disservice to the rest of the world, if you want to put it this way, by not fostering their entry into the use of enriched uranium reactors for power generation.

Senator GORE. To draw another down to earth comparison, do you think that enriched uranium is a more efficient fuel as high-octane is a more efficient fuel than relatively unrefined crude oil?

Dr. STARR. Yes; I think this is a proper analogy. If you have a choice to make your development based upon equal availability of these things, you choose the one which gives you the best long-term picture for economical development and economics.

Europe at the present time does not quite have this free choice. I think this is a ver serious matter to the United States in its international relations with these countries. I wish to make the point in this testimony that if that free choice were there, they would go the enriched route, and that this is a very important thing for us to keep in mind.

Senator GORE. I wish to extend my apologies for interrupting your statement, but you had touched on a point which I think is highly important and which I think has been neglected in the discussions thus far. I will not interrupt you further.

Dr. STARR. I am happy to have the interruption.

Representative VAN ZANDT. I do not think we want the record to show here that there is no effort being made to promote agreements. I think from a bilateral standpoint or through the other fields, there is such effort as far as atomic power is concerned.

Dr. STARR. Yes, sir.

Representative VAN ZANDT. Already we have 41 nations and 43 agreements, and in the power field I think we have 4 or 5. Were it not for the fact that the Euratom Treaty is now being considered by several countries on the Continent of Europe, we would probably have more bilateral agreements with several of those countries. I am reluctant to have the record imply that our Government is doing nothing about it.

Dr. STARR. I would agree with you, Mr. Van Zandt, and I do not believe I indicated that we were not doing anything about this. I was urging as a matter of fact, that this was a very important thing to do and that we should not perhaps look upon the enriched reactor development that we have in this country as not being suitable for foreign use.

Senator GORE. I did not understand the witness to imply that nothing had been done. I certainly did not mean to make any such implication. I do wish to say that although we are doing something, we are doing far less than enough.

Dr. STARR. If I may go on, in considering the manner in which the United States program for the development of atomic powerplants for peaceful purposes might be accelerated, it is well to consider what is involved in the development of any one basic approach to atomic power.

First, it is necessary that supporting research be conducted in the nuclear sciences, materials, and technologies in order to provide a basis for designing a particular experimental concept and for designing a pilot power unit to test such a concept.

The actual engineering and construction of such a pilot unit, perhaps in the range of 5,000 to 10,000 kilowatts of electrical capacity, involves the development and testing of specialized components which are required for the operation of the plant.

Associated with the operation of such a pilot unit should be an experimental recycling of the fuel in order to evaluate and develop the refueling techniques and the economic factors involved in such recycling.

Of the many reactor types which may be tested in the pilot-plant stage, a few of the most promising should be selected for the construction of central-station size prototypes. These prototypes must still be considered as experimental plants because of the variety of technical and operating problems which must be explored.

For example, the full-scale performance of reactor components, maintenance techniques, fuel reprocessing, waste-disposal techniques, the routines of operation and of fuel handling are some of the factors which will eventually determine the economic value of such plants and which can be developed successfully only on full-scale prototypes. The cost of such a program for any one reactor type will probably be between $50 million and $100 million.

EXPECTED EARNINGS INSUFFICIENT FOR REQUIRED DEVELOPMENT PROGRAM

We estimate that during the next decade the United States atomic equipment manufacturers may expect a total of about $1 billion of sales. Although the profit to be expected from these sales is uncertain, it is again our estimate that if these profits were utilized solely for the

purpose of supporting the investment in facilities required for atomic equipment manufacture, these profits would be sufficient to support only about a half-dozen principal manufacturers.

Alternatively, if these profits were utilized solely for development purposes and were pooled by United States manufacturers, only one or two approaches to atomic power could be carried through to completion.

GOVERNMENT SUPPORT OF PROGRAM MUST EXPAND

In view of the variety of approaches to atomic power which should be carried through the actual demonstration of prototype plants, it becomes a matter of national policy to provide the support for this development. Although the power utilities have undertaken partial financial support of these programs, it does not appear that the economics of the electrical utility industry, which is primarily concerned with the sale of power, would permit complete and continuous support of the required national development effort. It appears, therefore, that the support from the National Government, through the Atomic Energy Commission, must inevitably continue for some years as it has in the past, until economically competitive powerplants have been demonstrated.

In spite of the hesitance of industry to accept the concept of direct or indirect subsidy of industrial effort by the Government, it is appropriate that such support of atomic equipment development be accepted as sound national policy today.

There are notable examples in the history of our country where Government support has opened new technical and geographical horizons and has permitted the growth of strong industries and contributed to our national welfare.

This is an infant industry. The capital requirements are such that private means cannot possibly hope to supply all of the present needs for its development. This is not a new problem in this country by any means. The atomic-energy industry today can be compared with many other industries which grew and prospered under our system of private enterprise through Government aid at the outset. An excellent example is our air transportation industry.

In the early thirties, the Congress determined as a matter of policy that air transportation should be developed under the private enterprise system with Government aid. Without that policy, implemented as it was by congressional action, we would not have today the great air transportation system which this country enjoys in domestic operations as well as internationally.

Moreover, the air transportation system has grown beyond the need of subsidy. The same type of forward thinking should be applicable to the atomic-energy industry today.

There is no reason why we should depart now from the concept of private enterprise in this field any more than in the field of air transportation, the shipping industry, the mining industry, or the many other industries which obtained their impetus through Government encouragement.

Senator GORE. With apologies to you, Doctor, for again interrupting you, which I had not intended to do, I would like to ask a question here.

Are you aware of the fact that General Accounting Office only yesterday submitted a statement to this committee which casts a serious cloud upon the contractual relationships in the contract between the Atomic Energy Commission and the so-called Yankee group of utilities?

Dr. STARR. No, sir, I am not aware of this.

Senator GORE. We will not question you on that, then. I would be pleased to advise you that this did occur. One matter upon which the Comptroller General raised serious question was the failure of the private concerns involved to warrant performance under the contract commensurate with the government expenditure of funds.

Now, the idea of a concern, a private concern, giving a firm warranty of contractual performance under the present state of development of the art is quite difficult.

Dr. STARR. Yes.

Senator GORE. This report and your statement here present a challenge to this committee and to the Congress and to industry and to the Government. We must find ways of recognizing, validly recognizing, the mutuality of interest, the Government interest, the public interest and the private interest in this field.

It is a very difficult field in which to make firm contracts now. Would you think that that would be an added reason why the Government should foster research and development even to the extent of constructing demonstration reactors of various sizes?

Dr. STARR. I believe this is a very definite reason why the field at the present time requires continued Government support. I am suggesting that in addition to the support on research and development, there may be other forms of support which must be supplied.

I am also suggesting that because of the duration of time required for a sound development of this field, this cannot be taken care of by any temporary expedient. This must be taken care of eventually by well thought out subsidy programs.

What those programs would be in detail, I do not know, and I think there are more experienced people in the Government than myself to work out the details of such a program.

Representative COLE. Mr. Chairman, I think that it should be brought out that this report of the Comptroller General did not say that these constituent companies have refused to commit themselves to carry out the program.

The Comptroller General was critical of the Atomic Energy Commission in not specifically requiring that that be done, among other things. The Comptroller General report to the Congress also said that the Atomic Energy Commission had asked the Comptroller General for his suggestions and that they intended to carry them out in the future.

So, it would be a mistake, I think, for the understanding to be conveyed abroad that these constituent companies had refused to commit themselves to carry out the program, which I think, is not the fact.

Senator GORE. Well, to be even more explicit, I understood the Comptroller General's report to criticize the contract for its lack of such contractual warranties. It did not say that the constituent companies had refused to do so. It did not say that the Commission had refused to require it.

It just said it had not been done and it was not a part of the contract. I believe that was the content of the report.

Dr. STARR. If I may go on, Mr. Chairman, in the international sphere, American industry is already beginning to find competition in the atomic field from the more highly industrialized countries. Our asset of technical experience has given us a lead which will undoubtedly diminish as the skills of other countries develop.

For the United States manufacturers to play a principal role in supplying these markets, it is essential that we have a positive program for furthering the interest of domestic manufacturers on an international scale. The foreign patent situation in atomic energy is an important factor in these considerations. A review of this special problem is submitted as an exhibit. It is attached to this statement.

This study shows that the American position is extremely weak. For example, a recent patent search in 11 Western European countries, including France, Germany, and Italy, and Japan, has failed to uncover a single issued nuclear energy patent to the American Government.

As it now stands, neither the American Government nor American industry has a foreign patent position in the nuclear energy field of any consequence. This is a subject which requires detailed study and definitive action.

As a result of the considerations discussed, two specific recommendations are made. First, an accelerated long-range plan should be formulated for supporting the development of atomic powerplants until they are economically comparable with conventional plants.

Second, a positive program for supporting the development of the United States atomic-equipment industry in the export field be instituted. In this regard, it may be appropriate that the Atomic Energy Act of 1954 be amended to include as a purpose of the act the support and encouragement of the atomic-equipment industry in the export field.

As a clarification of my reference to a long-range plan for atomic-power support, I would like to suggest to this committee that the various proposals that have been put forward by the AEC and members of this committee are means of stimulating immediate acceleration of the activity in this field.

However, the effect of these proposals should be considered as short range in nature rather than the long-range subsidy which the atomic-power development requires.

This concludes my statement except for the short exhibit concerning the patent situation which I would be pleased to read if time permits and the chairman desires.

The CHAIRMAN. Thank you very much.

Representative COLE. I assume that the doctor's statement regarding the patent situation will be included in the record as a part of his statement, but I would like to have him, if I may, Mr. Chairman, verbally now and extemporaneously in a few words, tell us about this foreign-patent situation.

The CHAIRMAN. I think if you do not mind, it would be better for you to read that statement.

Dr. STARR. This presentation is concerned with the world competitive position of American manufacturers of nuclear reactors, and more particularly with the foreign-patent situation as regards nuclear-

energy developments. (See also letter amplifying Dr. Starr's statement on p. 302.)

The costs of power generation from conventional sources is considerably higher abroad than in the United States. Consequently, it is expected that nuclear power will be economically competitive at a much earlier date in foreign countries than in the United States.

American firms are already actively engaged in foreign reactor contracts, and it is clear that they may look increasingly to foreign markets for a large share of future business. We have such contracts in our firm.

Factors affecting entry to, and ability to compete in, foreign markets are studied with concern. The foreign-patent situation in atomic energy is considered an important one of these factors.

American firms engaged in enterprises in the foreign market must recognize the limitations imposed by foreign patents. American firms active in other fields generally take out foreign patents on their products. The foreign patents are secured to serve several purposes. The first is to prevent either outright exclusion from the foreign market arising from independent patenting of the same invention or the payment of high royalties thereon.

Another reason for taking out foreign patents is to protect the manufacturer against unfair competition by unauthorized use of his developments. Patents also represent valuable property, useful for industrial negotiation.

Foreign governments look to their patents as a source of revenue. A number of European governments have been aggressive in their foreign atomic-energy-patent policies. The French Government, for example, has taken very basic reactor patents in virtually every country in Western Europe, has filed patent applications in the United States, and is active in their exploitation.

We noted an instance of this in connection with our sale of a research reactor to Denmark, where the French sought to have their basic Danish reactor patents exempted from compulsory licensing, presumably so as to charge a higher royalty rate.

The French Government has also applied for an award before our Patent Compensation Board based on its American patent applications. The British Government, whose Atomic Energy Authority is actively promoting British nuclear interests in competition with private American firms throughout the world, also follows a vigorous patent policy.

For example, the British Government recently offered to grant licenses on a large number of its patents at a royalty rate of approximately 5 percent. Private organizations, notably the N. V. Philips Co., of the Netherlands, the European assignee of the fundamental Fermi patent on neutron moderation, are likewise actively exploiting their atomic-energy patents.

American suppliers will have to econsider the possible cost of licenses under extant reactor patents as a feature of their foreign activities. The pursuit of such a policy by these governments and private groups is certainly legitimate, as contemplated by the patent system, and cannot be objected to. However, it does raise the need for foreign patents in American hands.

Under present practices, American industry has not been able to obtain a satisfactory foreign patent position in nuclear energy. The

Commission is itself not active in the foreign market in a proprietary sense, and its patent program is, therefore, primarily concerned with the patent situation in the United States.

Not having the stimulus of an economic interest in foreign reactor sales, the Commission has never followed an active policy of taking out patents abroad on inventions owned by the Government. While patent searches are inherently not foolproof, a recent patent search conducted for us by a leading American firm specializing in foreign patent causes in 11 continental European countries (including France, Germany, and Italy), and in Japan, has failed to uncover a single issued nuclear-energy patent to the American Government. This contrasts rather strikingly with the United States, where well over 1,000 patents have issued to AEC, and it is understood that a like number are waiting to publish upon declassification.

It is appreciated that security regulations prevented the filing of classified patent applications by AEC outside of the United Kingdom and Canada, where the Commission has filed to some extent. Nevertheless, the Commission did not file such applications after declassification, but before publication.

As it now stands, neither the American Government nor American industry has a foreign patent position in the nuclear-energy field of any consequence. This is in spite of the major contributions made by the United States to this field, the large expenditures of public funds and the initiative and devotion of private industry.

It is considered that, while the Commission has protected itself in the patent provisions of research reactor bilateral agreements, American industrial interests have not likewise been protected. It is noted that, while information is undoubtedly fairly interchanged, our technological art is more advanced and American firms working on advanced reactor cycles will find small interest in the simpler systems favored by the Europeans.

The typical agreement, with the United Kingdom, provides that each country will exchange title to inventions resulting from the interchange of information in the country of the other, subject to a license to each government for governmental purposes. The agreement further provides that each country will retain title to their own inventions in their countries and will grant licenses to citizens of the other country on a nondiscriminatory basis.

However, there is no positive requirement for the grant of licenses to their respective citizens or prohibition against royalty charges. Since patent licenses are not required to suppliers of the British Government, and the British Electrical Authority is an arm of the Government, we can foresee that substantially no licenses need be granted, or if granted, only at a fee.

Furthermore, information transferred under the bilateral agreements may result in the independent patenting outside the United States of an invention made under a Commission contract by an American firm, for European laws permit patents to issue to the first applicant rather than to the original inventor. Thus, as a consequence of the American contractor to the AEC not being able to acquire exclusive United Kingdom rights, the firm might find itself, by way of example, paying royalties on its own inventions in Britain, even if such licenses were to be granted.

While there is yet no evidence that this has happened, it is a logical expectation in view of traditionally aggressive European patent practices. A very similar factual situation exists regarding the recent exchange of patent application holdings by the British and American Governments in the country of the other.

It is submitted that the net effect of these agreements is to buttress the position of foreign governments in competition with American companies.

The terms of AEC contracts deny the contractor any proprietary foreign patent rights, even in joint programs where the contractor has furnished substantial capital. The Commission has indicated a willingness to let contractors file abroad nonexclusively on their inventions which are assigned to the Commission.

However, the filing and maintaining of foreign patents is very costly. Without the possibility of compensation, especially in the form of a proprietary interest in the patent, foreign filing by contractors on Commissioned-owned inventions cannot be expected to any extent. Furthermore, the contractor would need a controlling interest in any patent obtained at his expense to insure that it is not disposed of to his detriment.

As another reason against nonexclusive filing abroad by AEC contractors, publication is an immediate bar to patenting in most European countries; therefore, publication would yield about as much protection as a nonexclusive license.

Section 152 of the Atomic Energy Act of 1954 holds that all atomic-energy patents presumably belong to the Government, unless overcome by a verified showing to the contrary. To get the benefit of the international convention, a foreign-patent application must be filed within 1 year of the American application. But before this filing is undertaken, the applicant naturally wants to determine what interest he will have in the patent.

The Commission has indicated, however, that a final determination of patent rights cannot be made under section 152 until such time as the American patent is about to issue, which is usually several years after the time for the foreign filing under the international convention.

Thus, the applicant is faced with a dilemma. If he does not file within the year under the international convention, valuable foreign rights may be lost, and if he does file without any assurance as to his interests, he may have expended large sums of money only to lose the patents to AEC.

In summary, it is submitted that the competitive position of American industry in foregn atomic-energy activities is being adversely affected by the patent practices resulting from the Atomic Energy Act, to the benefit of foreign competition.

It is considered urgent that a strong foreign patent position in atomic energy be established quickly. This will be best accomplished if the task is left to those with the strongest economic incentives to insure the best patents are filed and then maintained when subject to taxation.

It is believed that the Government could not as effectively undertake this active program in behalf of American industry because of the absence of an economic incentive and because its purposes might be misunderstood abroad. Therefore, it is recommended that the patent

clauses of all Commission contracts be amended to grant to the contractor the right to file abroad on inventions developed under the contract and to own the resulting patents.

The interests of the Government would be preserved through the grant to it of a royalty-free license in any resulting patent, and licenses could be negotiated with other American firms.

The adoption of this recommendation would insure that an active patent policy is followed in all important industrial countries and that the American share of the foreign nuclear-energy market would be commensurate with our contributions to the development of peaceful atomic energy.

Now, I might submit for the record a quotation from what I would consider a higher authority than myself in patent law. That is Casper W. Ooms, former Commissioner of Patents and the present Chairman of the Patent Compensation Board of the AEC, with whom I think the committee is familiar.

I will quote a paragraph from a speech which he gave a year and a half ago:

> My review of the history of the patent problems of atomic energy leads me to the conclusion that as far as the subject of patents in this field is concerned, we have troubled ourselves about nonexistent problems and overlooked what may be the most serious problem in the field, namely the foreign patents. To recognize this may be a large part of the solution of the problem.

The CHAIRMAN. Thank you very much for this very interesting statement and your bringing some of these problems to our attention. Some of these patent problems are complicated and we all recognize that.

We do not expect to operate entirely perfect and I think the committee expects to go into that thoroughly at a future time.

Representative HOLIFIELD. I want to see if I understand your recommendation on page 5, Dr. Starr. You say,

> Therefore it is recommended that the patent clauses of all Commission contracts be amended to grant to the contractor the right to file abroad on inventions developed under the contract and to own the resulting patents

Now, I would like to know just how this would apply. Would this apply on research and development contracts where the Government would put up let us say $25 or 30 million for research and development on the projects such as the Shippingport contract and that in putting up that money to develop anything in that field, any of the industrial contractors that might be working on the job under the contract could file patents on the results of the expenditure of Government funds?

Dr. STARR. In essence, Congressman Holifield, it means what you have indicated. We normally, and by "we" I mean agency contractors, normally have a responsibility to disclose and file on behalf of the Government or behalf of the AEC, any patents which evolve out of the research and development for which the Government is paying wholly or in part.

This protects the United States Government domestically and makes the patents available to all American industry.

Now, what I am recommending is that on the very same thing in which we protect the United States Government in the United States patent-wise, the company doing the work be permitted to file abroad and receive title for the patent abroad and not in the United States

and give the Government a royalty-free license to use the rights abroad for anything it wishes and as I also indicated, there would be negotiations under any arrangement which the act will indicate, permitting other American industry to share these rights abroad.

Representative HOLIFIELD. It would not become the exclusive ownership of the company involved in foreign fields, but it would become, you might say, an ownership in trust which would be available to the rest of American industry on a free basis to protect them against a great number of foreign competitors.

Dr. STARR. It would be essentially an ownership by American industry rather than by the American Government of the foreign rights. As I indicated, the history of this activity indicates that there is nothing actually in the Act and no motivaiton for the Atomic Energy Commission to have a special interest in this particular field.

There is a motivation for the atomic equipment industry in the United States.

The CHAIRMAN. Was that not brought about by the conditions in the bilateral agreements?

Dr. STARR. Not completely. The bilateral agreements did trade patents rights, and as I indicated in my statement, while the United States Government received rights to British patents for example, from the point of view of American industry we were trading a big stockpile for a little stockpile.

The other aspect which has interfered has been the aspect of publication. There has been a policy and perhaps in many ways a very good policy for the immediate publication of all declassified information.

As soon as such information is published, then in most countries throughout the world, other than the United States, in effect it is impossible to patent at that point. What would ge required here would be an intermediate time element by which American industry could establish foreign patent rights.

Now, the actual working method by which my suggestion might follow would be simply this: When American industry develops a new idea which justifies patenting, that patent application is made to the patent office within a matter of days or weeks and it does not necessarily follow a parallel with the publication of reports. It is conducted on a much quicker basis time-wise. Now, if at the same time the contractor of the AEC had the authority to file in their own name outside of the United States, then the patent application would be made prior to the publication of unclassified information disclosed in the work.

I think the mechanism by which this would work would be protective to American industry if American industry had this right to do as I have suggested.

Representative HOLIFIELD. You would not think that there would be any trouble between American industrial firms in allowing each other to use these patent rights in competition. There would be two phases of competition. One phase would be that the American companies might be competing for the same contract, and one company would hold certain patent rights.

Then, the second phase, of course, would be the competition with the foreign companies. Would you anticipate any trouble or any re-

luctance on the part of an American industrial firm who had had occasion to file on some important patent, allowing another competitive American firm to use that in competition either locally or in foreign trade?

Dr. STARR. Congressman Holifield, I think it is quite clear that if any one American firm could maintain complete proprietary rights, it would be more desirable for that firm. But, it is also because of the atmosphere and the conditions under which these developments are created, I think American firms would find it an equitable solution to share these foreign rights. At the moment, my concern is that it is not a question of one American firm against another, but it is a question of American industry against European industry where we do not have this protection at all.

Speaking for our company, and I certainly cannot speak for the others, we would not be reluctant to permit other American firms to share these patent rights.

Representative HOLIFIELD. It would seem like some type of American holding company for these patents could be charged as a depository for these patents. That might be worked out.

We do have the Export-Import Bank which is, in a manner of speaking, a kind of holding company for different financial interests which wish to participate in a foreign venture. I was thinking of something where the responsibility and the advantage might be deposited in an objective third party rather than in the first party of interest.

Dr. STARR. I think this, Congressman Holifield; while this certainly could be done, I doubt whether it would be necessary. American industry has, in many traditional areas, made exchange of patent rights for the good of an industry as a whole. I would expect the same thing would occur here.

The way this works, is quite practicable. Any contractor of the Commission is going to have a bulk of such patents if such a procedure were to go through. It would be equally advantageous say, for my company to have available the rights to some other company as it would be for them to have rights to mine. There is a very practicable leveling device which tends to distribute these rights among the people who have them.

I doubt if any form is necessary to do that, although a form such as you have suggested would certainly be workable.

Representative HOLIFIELD. I think there is certainly a field there of protection which American industry should have as a group against foreign industry. I think we would have to watch carefully and see that advantages were not given to certain industries who by virtue of contracts with the AEC have had prior access to techniques and patentable hardware, or ideas for patentable hardware which would put them in a position of advantage over other American companies in the foreign field.

If it could be worked out, I would think that such a procedure would be well worthy of our consideration.

Representative COLE. Mr. Chairman, I would like to compliment Mr. Starr for having brought to the attention of the committee the situation. Whether it is the result of a defect in the law or not I am just not clear. It is my impression from your presentation that the operation of the act is not the cause of the situation, but rather the operation of the patent laws and patent procedures and the time lag as well as the

absence of an aggressive and compelling action on the part of the Commission either to permit the patentor or of the Commission itself to protect the American interests by filing abroad.

I assume that this must have been discussed rather extensively in the Commission. Has it not?

Dr. STARR. I can't speak for the Commission, Mr. Cole.

Representative COLE. I realize that. What have you found the Commission's attitude to be?

Dr. STARR. I think the Commission does not have in the act a clear-cut responsibility for protecting American industry abroad.

Representative COLE. There is nothing in the law to stop it.

Dr. STARR. True, but also there is no responsibility stated in the law. I suggested in my testimony that the act be amended to indicate that one of the purposes of the act would be to protect American industry abroad.

With that in mind, the Commission's patent policies have been primarily concerned with the protection of the United States Government and its freedom to operate, and it has done a very good job along these lines.

The other aspect of this, which I indicated, was the inhibiting effect which the present act places upon taking out patents abroad because of the lack of a clear statement early in the game as to what the proprietary rights of anyone is in a patent in this field, and this delaying action interferes because of the complexity of foreign patent laws.

Representative COLE. May I ask a favor of you, since you are so well acquainted with this problem and since you have at your disposal such competent legal counsel, that you submit to me or to the committee a proposed change in the law which would correct what I feel to be a situation which is in need of correction.

Dr. STARR. We would be very happy to do so.

Representative PRICE. Dr. Starr, do you believe that the reactor equipment manufacturers will encounter any substantial increase in the cost of their experimental prototype plants over their original cost estimates?

Dr. STARR. I suspect that this is true. It has been true for us.

Representative PRICE. What is the reason for this?

Dr. STARR. There have been two factors which have given rise to these cost increases. One has been the opening up of technical areas that have not in the original planning of these reactors been anticipated, difficulties which had not been anticipated but which as the work progressed and the development work continued became major questions of a technological nature.

The other area has had to do with the quality of construction which reactors require. It has been extremely difficult for us and I believe for other reactor manufacturers also in general to get the quality of fabrication into the various components that go into the pieces of the reactor. This has required so much more in the way of labor, examination, and rework that it has contributed both to cost and to time scheduling.

Representative PRICE. Have you any way of estimating about what the average increase has been?

Dr. STARR. I could guess, based on our experience. Again, it is very difficult to generalize in this field. It varies from reactor to

reactor. I would say just construction costs alone are apt to be 20 to 40 percent higher as a result of the special quality required in reactor construction.

Representative PRICE. What effect has it had on scheduling of reactor projects?

Dr. STARR. If the vendors or the workmen in the field have had experience and have been through this perhaps once or twice, then the schedules might originally have been more realistic and maintained, but when the workers are new, the vendors are new, difficulties arise from what we call rework, where the equipment comes to the field or is assembled in the field and will not pass the inspection which is maintained by most manufacturers of this type of equipment.

This means that it goes back to the manufacturer and has to be completely redone. This may mean delays of anywhere from 4 to 6 months just on major components.

Representative PRICE. What arrangements have been made for the disposition of the power from your sodium reactor experiment?

Dr. STARR. The sodium reactor experiment has attached to it a powerplant which has been built by the Southern California Edison Co., and that power would go on to their lines. The powerplant and the distribution of that power was the result of a contract operation with the Atomic Energy Commission some time ago. They went out for proposals from the utilities in that area, and of these proposals Southern California Edison was selected by the Board. Southern California Edison has put up with its own funds the complete power generation equipment.

Representative PRICE. What capacity is involved?

Dr. STARR. It is rated at about 6,000 kilowatts of electricity.

Representative PRICE. Is that firm power?

Dr. STARR. Oh, no; this is not firm power. The primary objective of the sodium reactor experiment is just what the title indicates. It is a program for doing experiments. Southern California Edison takes the steam whenever the steam is available.

Representative HOLIFIELD. You actually are delivering power from it?

Dr. STARR. That is correct.

Representative HOLIFIELD. What is the proportion of investment between North American Aviation and the AEC in the reactor?

Dr. STARR. It is a little over 20 percent of the total present cost.

Representative HOLIFIELD. North American's contribution is about 20 percent?

Dr. STARR. A little over.

Representative HOLIFIELD. And 80 percent from the AEC?

Dr. STARR. Yes.

Representative HOLIFIELD. Who has title to the reactor?

Dr. STARR. The AEC.

Representative PRICE. Dr. Starr, what are your views on atomic reactors for ship propulsion?

Dr. STARR. In addition to the sodium reactor experiment, we have the development of what is called the organically moderated reactor experiment which is undergoing construction at Arco, Idaho. This particular type of plant has certain characteristics which make it technically very desirable for ship propulsion. We have had a pro-

gram for studying this application for the Maritime Administration-AEC combination which has been established. The results look extremely promising, sufficiently so that it is our opinion that in terms of competition on a true commercial basis the merchant marine application is apt to arrive much sooner than central-station power generation.

Representative PRICE. Have you any ideas on a particular type of ship in which it might best be tested?

Dr. STARR. Nuclear reactors have this one characteristic: The bigger anything is built, the more economic it becomes. It turns out that the tankers and especially the very large tankers which recently have been proposed are ideal for nuclear powerplants. This is a matter of economics that go into maritime use. A ship which is at sea a very long time would ordinarily have to carry a larger reserve of fuel oil, whereas the size of the nuclear reactor is to a great extent independent of the amount of time a ship is at sea. So for the very large ships which cannot go through the Suez Canal, for example, and where the transit time at sea is very great, the nuclear powerplant begins to look economically very desirable.

Representative PRICE. If you were given the job of doing it, how far away do you think it would be before you could produce a tanker with atomic propulsion?

Dr. STARR. This would again be a guess. It would depend upon the amount of funds, the speed with which one was asked to do the program, whether it was taken at easy stages or under pressure. But I would guess 3 years is a reasonable time to get technological development.

Representative PRICE. Three years?

Dr. STARR. Three years.

Representative PRICE. What would you say would be the main advantage of atomic tankers as against the conventional tanker?

Dr. STARR. I think for one thing there is this matter of fuel economy. Again, it is very difficult to generalize. There are many things that go into the economics of the operation of ships, and different tanker lines have different ways of operating ships. They utilize their crews differently. They utilize different shipping lanes. As a result, it is hard to tell. The studies we have made and the discussions we have had with several of the tanker groups indicate that the very large tankers under the right development circumstances actually result in lower cost per ton-mile with nuclear powerplant than with conventional fuel.

Representative PRICE. What are the advantages of organically cooled or moderated reactors?

Dr. STARR. The organic is chemically nonreactive with the components of the reactor, and this lowers to a very enormous amount the corrosion problem associated with most reactor designs. Further, the organic can be kept liquid at temperatures at which water would normally have very high pressures. So instead of having a high pressure water system, for example, as one might have, with either a boiling or pressurized water reactor and the corrosion problems that go with these two applications, one now can operate the organic power plants at a much lower pressure and without the corrosion problem. It has a disadvantage. The disadvantage is the fact that the organic

liquid decomposes under radiation, and part of our work for the Atomic Energy Commission for some years has been the development of organic liquids in which the decomposition rate is kept very small. The organic moderated experiment at Idaho has as its purpose the first full-scale test of this. However, our pilot tests which we have done with liquid are very promising and indicate that these are satisfactory liquids to use. The net result will be a small, compact powerplant without the problem of corrosion and difficulties that might be involved both hazardwise and maintenancewise with the high-pressure water system.

Representative PRICE. Do you feel that you are moving along pretty well in this study?

Dr. STARR. That particular development has gone very nicely and we are very much encouraged about the possibilities. I might point out that the British recently announced that they have formed a group under the auspices of the British Atomic Energy Authority to look into maritime applications, and the only reactor type specifically mentioned in their announcement was the organic moderated reactor type.

Representative PRICE. Doctor, in your statement on page 1 of the patent section, while you refer primarily to the patent difficulties at this time, you state that American firms are already actively engaged in foreign reactor contracts, and they may look increasingly to foreign markets for a large share of increased business. What has been done by our American firms engaged in the reactor business abroad? Have we sold or built any reactors over there?

Dr. STARR. We have sold many research reactors, and these I think have been enumerated at various times before this committee. On power reactors two sales have been publicly announced by Westinghouse, one to Belgium and one to Italy.

Representative PRICE. What has happened after those announcements?

Dr. STARR. I believe the one for Belgium is proceeding. The one for Italy is pending a resolution between the buyer in Italy, which is a private utility, and the Italian Government. We do not I believe have a power bilateral between ourselves and Italy as yet, so there is an unresolved problem of United States-Italian Government relationships and Italian private electrical utilities relationships in Italy.

Representative PRICE. Has any foreign government solicited your company?

Dr. STARR. Yes, our company has been solicited by several foreign governments. We have proposals out to several foreign purchasers for power reactor components.

Representative PRICE. When I say foreign government I mean also industry abroad.

Dr. STARR. I also meant industry, foreign buyers. I might point out that we have been asked by American foreign power to a supply for some Latin American country which as yet has not been named, a 10,000-kilowatt powerplant using this organic moderated reactor concept.

Representative PRICE. If you were successful in negotiating a contract with some foreign buyer, would there be any particular obstacle

in your way of delivering a reactor to him within a certain time or a given time?

Dr. STARR. Once we have committed ourselves to the schedule—we try to make these schedules as realistic as we can and I would assume that if we had established such a schedule we could deliver. We are delivering research reactors on schedule.

Representative PRICE. Just for a moment let us consider power reactors, from which to generate electric energy. When the Japanese were searching for what they might consider at this time the best buy in reactors did they approach your company?

Dr. STARR. Yes.

Representative PRICE. What experience did you have with them?

Dr. STARR. We have made proposals to them. The proposals are still under discussion. They are very energetic people from the point of view of soliciting information. We have continuing and voluminous correspondence explaining and reexplaining many points of the proposal.

Representative PRICE. Did you find any obstacles in your way in dealing with them to produce on the contract in case you were able to make one?

Dr. STARR. There are certain obstacles that I think do exist in this business. One is the patent field. When we sell to a government we normally ask the government to assume all patent indemnity as far as any infringements are concerned in their own country. When we sell to a private buyer this problem is unresolved as to how this is handled. The other has to do with the problem of third-part liability which this committee has heard much of, I am sure. This problem also exists overseas for American manufacturers. How this problem will be handled I do not know. The buyers of these plants or the proposed buyers of their powerplants overseas are themselves trying to straighten out this type of problem with their own governments, but this is still an uncertain area and a very important one from the point of view of power reactor sales overseas.

Representative PRICE. Have they drawn a comparison between what you were able to offer them and what the British were able to offer them?

Dr. STARR. Yes, they have. Just to give you a general statement, they have repeatedly indicated that technologically they feel that what American industry has to offer is of more interest technically from the point of view of eventual performance than what the British have to offer, but they seem very much concerned with this problem that I alluded to earlier, the availability of enriched fuel, the reliability of its availability.

Representative PRICE. That is all I have, Mr. Chairman.

Representative HOLIFIELD. I would like to clear up one point, Dr. Starr. I think I am aware of the way you solved the purpose-clause problem in the release of your power for the Southern California Edison Co. That is a matter of continuing concern to the committee, and I think it might be well for you to explain for the record just how that was handled.

Dr. STARR. The proposals were requested by the Atomic Energy Commission from the utilities in all of southern California, both public and private. There were considerable discussions among the

utilities themselves. The biggest private utility, the Department of Water and Power of the City of Los Angeles, arrived at an understanding with Southern California Edison by which all the information which would be developed by Southern California Edison on this plant would be made available to both the Department of Water and Power and the other utilities in the southern California area. The way the agreement now stands between the AEC and Southern California Edison, all the utilities in that area have equal access to both the property and the information to which the Southern California Edison has access.

Representative HOLIFIELD. I think that is a reasonable and very fair way to solve this problem which does become vexing in some areas. I knew, of course, of that solution. In some areas it might not be possible to solve it that way, but it does show that what we are seeking here at this time is actually knowledge of the development of a new industry and not the end result of the kilowatts which, particularly on an intermittent basis, is not a very valuable property. I compliment your group on solving that problem.

Your reactor uses a sodium solution?

Dr. STARR. Yes.

Representative HOLIFIELD. Are you having the same trouble with corrosion that seems to be accompanying all of those reactors with that type of coolant?

Dr. STARR. Congressman, you are probably alluding to the *Sea Wolf* difficulty.

Representative HOLIFIELD. Yes.

Dr. STARR. The corrosion which occurred in the *Sea Wolf* was on the water side rather than on the sodium side of the boiler. For very many technical reasons the design of that particular boiler is not the same as the ones which we are utilizing for the sodium reactor experiment or that we would utilize in any full-scale plant. We do not expect to have those difficulties in our plants.

Representative HOLIFIELD. In other words, you do not think that it is inherently an inevitable result that, if you use sodium, you will have trouble with your valves and conduit pipes, and so on?

Dr. STARR. No. Sodium is a new material. We have to learn how to handle it. The problems which have occurred with the *Sea Wolf*, while of very great interest, do not pertain to the design and the problems which we would expect to get on land-based plants. I don't want to leave the impression that we are not having trouble. Actually these troubles have been pretty well handled by more or less traditional engineering approaches. I would say that it is important that the handling of sodium be solved as a technical problem for the field as a whole, because not only our reactor but, as you know, the fast breeder program depends upon the use of liquid sodium.

Representative VAN ZANDT. In your statement under specific recommendations I am especially interested in recommendation No. 2, where you say:

> A positive program for supporting the development of the United States atomic equipment industry in the export field be instituted. In this regard, it may be appropriate that the Atomic Energy Act of 1954 be amended to include as purpose of the act support and encouragement of the atomic equipment industry in the export field.

Let me ask what you mean by support and encouragement? Can you be more specific?

Dr. STARR. Yes. I can answer this question best by indicating that it is our very distinct impression that some of our strongest competition in the sale of reactors comes from England. When we compete by discussing with these customers the possibility of getting American reactors we find that American industry is talking on one side but either directly or indirectly the British Government is on the other side. It is very hard to distinguish abroad between the sales efforts of the British Government, that is, the United Kingdom, and the sales efforts of their companies.

Representative VAN ZANDT. In other words, your foreign competitor is government subsidized.

Dr. STARR. I don't know whether this is the right term to use. He is certainly working very closely with his Government on the sale of reactors.

Representative VAN ZANDT. Would you recommend that the Government subsidize the atomic equipment industry in this country to meet foreign competition?

Dr. STARR. I think in this field of general subsidy which I recommended for the atomic equipment industry this is one of the areas that should be covered; yes.

Representative VAN ZANDT. For the purpose of establishing some idea of the development of the atomic-equipment industry, when was the atomic international division of North American Aviation first established?

Dr. STARR. We started work in 1946 as a portion of the general work being done for the Air Forces.

Representative VAN ZANDT. What was your capital investment at that time?

Dr. STARR. In this particular field very small, probably just in the nature of housing facilities and the like.

Representative VAN ZANDT. Are you at liberty to tell us what it is today?

Dr. STARR. Yes. We have roughly $5 million worth of capital tied up in this field.

Representative VAN ZANDT. And you are expanding?

Dr. STARR. Yes.

Representative VAN ZANDT. You are one of the big atomic-equipment suppliers of the country today, together with General Electric, Westinghouse, and others.

Dr. STARR. Right.

Representative VAN ZANDT. Do you think a Government subsidy would help considerably?

Dr. STARR. Yes. Again this field of subsidy is very complicated. I think it has to be looked at in great detail. The subsidy does not have to be directly to the manufacturers, other than the subsidy which we are actually getting now in the form of research and development support, which not only is necessary but which we suggest be continued and enlarged. The financial subsidy, I think, must go somehow to the customers, to the people who use the equipment. It could go to the manufacturer, but it probably would be equally effective and maybe more so if it went to the customers.

Representative VAN ZANDT. Is it safe to assume that the majority of the activities in the equipment industry is primarily in the field of research reactors?

Dr. STARR. No. I think that the research-reactor business is utilized by us and by most of large American industry as a practice field for discovering what problems are involved in foreign sales. The problems I have mentioned to you today in patents have come to our attention as a result of this exercise. We have not looked upon the research-reactor field as something which is a profitable thing by itself.

Representative VAN ZANDT. Leaving the research reactor and the power-reactor field, where does the rest of your business come from?

Dr. STARR. I would say we are roughly over 90 percent supported by the Atomic Energy Commission.

Representative VAN ZANDT. Repeat that, please.

Dr. STARR. We are over 90 percent supported by the Atomic Energy Commission, either directly or indirectly, in the form of reactors which are being constructed through Government sponsorship.

Representative VAN ZANDT. That would leave 10 percent coming from nongovernmental sources?

Dr. STARR. Yes.

Representative VAN ZANDT. Is the nongovernmental support increasing annually?

Dr. STARR. We had hoped it would increase at a faster rate than it has. We are looking forward to its increasing. As a matter of fact, that is our end objective. As you probably have been told on the committee many times, doing research and development for the Government in a monetary sense is not very rewarding.

Representative VAN ZANDT. Thank you.

Representative HOLIFIELD. Senator Bricker, have you any questions?

Senator BRICKER. No; I have no questions.

Representative HOLIFIELD. Senator Dworshak?

Senator DWORSHAK. No questions.

Representative HOLIFIELD. As I gather from your statement, Dr. Starr, you are frankly saying that this art is progressing slowly, that if it is to progress as fast as the international competition indicates it should progress, it will have to be done with some form or other of Government subsidy.

Dr. STARR. Yes.

Senator BRICKER. There is one question. I note on page 3 a reference to a free world market in enriched uranium. You would not advocate the establishment of a free market in that, would you?

Dr. STARR. What I indicate here in this testimony is that, because of lack of such a market, foreign countries hesitate to embark upon a program which would utilize enriched uranium.

Senator BRICKER. I appreciate that is what you said, but do you think it is possible to create a world market at this time with the attitude of the governments being what they are?

Dr. STARR. I think it is inevitable that such a market will occur. The British are already producing enriched uranium and are offering it in small quantities for sale to other countries. We have made announcements to the effect that enriched uranium will be available to other countries.

Senator BRICKER. It is part of the bilateral program.

Dr. STARR. Also, I believe, the President's program through international agencies.

Senator BRICKER. That is far from making a world market.

Dr. STARR. I agree with you that is not a world market, but I think eventaully there will be other agencies or countries which will be able to produce enriched uranium. This is one of the possible programs, for example, that Euratom has indicated might be of interest to them. Whenever there are enough sources so that enriched uranium can be bought by a foreign country on a competitive-bid basis you have in effect a free market.

Representative HOLIFIELD. Are there any further questions?

Mr. Van Zandt.

Representative VAN ZANDT. Do you think the Commission's most recent announcement of reprocessing will help the situation?

Dr. STARR. The announcement on reprocessing?

Representative VAN ZANDT. Yes.

Dr. STARR. I think that this will be of assistance. I might point out that one of the biggest economic obstacles in selling enriched fuels to foreign countries has been the unknowns associated with the delivery of these fuels, the reprocessing, the value of plutonium. The Commission's statements up to now have indicated a step-by-tep development of cost. There are still some intangibles. This could be one form of such a subsidy as you mentioned before by which, for example, these people were charged only for the material they used up, the uranium 235 they used up, and the cost of fabrication of the element, and we in return would be getting the fuel element back and absorbing the plutonium ourselves, absorbing all the other processing costs. There is a vagueness at the moment about the total cost of fuel cycle which leaves the cost of fuel a little uncertain.

Representative VAN ZANDT. In your negotiations with the Japanese Government, if you would have had the privilege of reprocessing fuel as authorized by the recent directive of the AEC, do you think you might have been more successful?

Dr. STARR. It would have been a very big help. We could have been less vague about what it would cost them to operate.

Representative VAN ZANDT. That is all, Mr. Chairman.

Representative HOLIFIELD. Thank you very much, Dr. Starr, for your testimony and your responses to the questions.

Our next witness is Theodore S. Kenyon, partner in the law firm of Kenyon & Kenyon, New York, N. Y.

Mr. Kenyon, will you please come to the witness stand? Before you start, let me announce that this room will not be available for this committee tomorrow. Our meeting will be held in room F–41 of the Capitol at 10 a. m. and 2 p. m. tomorrow.

Mr. Kenyon, you have a prepared statement. Will you please give us the benefit of it at this time?

STATEMENT OF THEODORE S. KENYON, NEW YORK, N. Y.

Mr. KENYON. My name is Theodore S. Kenyon. I am a member of the New York bar and have been practicing patent law there for over 40 years. I have come to urge upon this committee that Congress amend the 1954 act by removing all secrecy restrictions on

atomic information except for those relating specifically to atomic weapons.

I know that this is a problem which has deeply concerned you. You have had the benefit of the fullest information and have heard testimony in public and behind closed doors as to the character and importance of the restricted data which the Commission believes is still secret.

Outsiders, like myself, are in comparative darkness. Obviously we know nothing of these innermost secrets. We can only judge of the intolerable penalty which the restricted data program imposes on our economy and our future security by contrasting the halting progress of atomic science today with the unrestricted growth of other sciences under the impact of our free enterprise system.

I have come here primarily because of my conviction that by the restraints on the dissemination and free exchange of atomic information which we Americans have imposed upon ourselves by the provisions of the present law, we are deliberately paralyzing the development of atomic science in this country and laying the basis for a far greater threat to our future security than would result from the release of all presently classified material except that relating strictly to the weapon field.

In 1953 when the 1954 act was being considered the House bill contained a clause with respect to the declassification of restricted data within 3 years, section 145c which read:

> No restricted data shall be so classified for more than three years after its origination or after its redesignation unless there is a specific finding made within six months preceding the end of any such three-year period that the common defense and security require that that restricted data retain its classification for an additional period of up to three years beyond the end of the preceding period.

That provision was not enacted. Instead the declassification of restricted data was left to the Commission with the admonition, in sections 142a and b, to determine from time to time the data which can be published without undue risk and thereupon to cause such data to be declassified.

The Commission has established a declassification division which has worked valiantly to carry out this requirement. At first the division released data by the spoonful; more recently it has released data by the shovelful. But under the definition of restricted data contained in section 11 (r) every original thought concerning "the use of special nuclear material in the production of energy" is "born classified" and may not be uttered publicly until it has been passed through the mill of the declassification division.

The effect of this enforced secrecy on the teaching and dissemination and growth of knowledge of this science has been profound. Colleges and research centers have worked under serious handicap. Teaching and discussion have been limited to basic knowledge and material known to have been declassified. Education of advanced students faces the barrier of restriction on advance information. Scientists and engineers cannot communicate with one another except under the rigid controls of the Commission. As a practical matter, no one outside the officials of the declassification division knows with certainty what is declassified and what is not. Outsiders dare not publish an original thought or indeed anything except what they know to be stale. The tragedy is that in atomic science, where we

need it as never before, and where we are counting on the proven strength of our technology to lead the world, we are, by our own self-imposed law, strangling the very forces that are essential to our national purposes.

Senator BRICKER. Your assumption is that everybody connected with the atomic energy program, the Congress included, have been wrong in the classification. Do you come to that conclusion from reading, from what you heard, from some personal experience that you have had? If it is from your personal contact and experience, what has it been?

Mr. KENYON. From a lifetime of experience, sir, knowing that industrial progress grows by the exchange of information. I am going to come to that, but that is the basis of it. I have four reasons which I present in my statement for believing that this policy is now obsolete and seriously dangerous to us.

Senator BRICKER. When did it become obsolete, in your judgment?

Mr. KENYON. I should say just about now. When we were considering this thing in 1953 I had the privilege of testifying about it and I told Congressman Cole that in the judgment of the man who is in charge of one of these programs of the Commisison, 2 years was the time within which this material should be declassified. Now it is 4 years. In the meantime we have struggled. It is 4 years since 1953.

Representative COLE. I can add to that. Do you mean to say that there have been concepts presented to the Commisison for determination with respect to classification and the Commission has failed to reach a decision within a period of 4 years?

Mr. KENYON. No; I don't say that. I think the time has come and is fully upon us now, when its consequences are becoming increasingly dangerous if we do not now take off these chains and let the science grow as other American sciences have grown.

Senator BRICKER. You mention "the effect on the teaching and dissemination and growth of knowledge of this science has been profound." In other words, it has been handicapped seriously, you say. I happen to be a member of the board of trustees of one of these educational institutions and there isn't a meeting that we do not have a research program that is authorized in the field of atomic energy. If it is true in that school it is true in other schools, also.

Do you not think that the educational institutions have had adequate opportunity for research and for the gaining of knowledge in this field that the Atomic Energy Act has not inhibited?

Mr. KENYON. No, sir; I certainly do not. I read the paper that Dr. Persegian gave this morning. He is in charge of the nucleonics program at Troy. I have gained information from him. I have gained information from Michigan. This is secondhand, but the scientists are under a profound handicap because they cannot get into this program unless they are cleared and have access. They can only exchange information with respect to things that are declassified. They cannot think ahead and discuss the things that are coming. That is the basis upon which growth depends. You cannot grow on what is old. You can build on it, but growth depends upon imagination, upon stretching forward. Until the information has passed through the Commission mill and been declassified, these gentlemen in your universities cannot discuss it with one another.

Senator BRICKER. I am amazed we have gotten any place taking your premise.

Mr. KENYON. I would refer you to that paper that Dr. Persegian read this morning because I think it presented the situation very fully.

Representative HOLIFIELD. As a matter of fact, there is a great area where the teachers themselves are cleared and they are not allowed to pass it on to the students.

Mr. KENYON. Exactly. Those who are not cleared, although they might have potentialities, cannot discuss this thing with those who are not, and vice versa. No science has ever grown under such circumstances in this country.

Representative HOLIFIELD. As Senator Bricker has said, I think we have had a remarkable growth of this science in the last 10 years. I think to deprecate the progress that we have had is to be not quite fair. I think we have had a wonderful advancement in it. This committee has been faced with this problem of course from the inception of the committee 11 years ago. There have seemed to be areas of dual use which have had to remain classified because if you released it, for instance, in the peacetime application field you would also release it for its application in the weapons field.

So always has been this struggle in our minds as to how to draw the line and what we could afford to declassify.

Mr. KENYON. That is all I am asking for.

Representative HOLIFIELD. We are still struggling and I think the Commission is struggling. In the last 3 or 4 years the pace at which declassification has occurred and the whole attitude toward it are completely different than 3 or 4 years ago.

Mr. KENYON. The Commission has done a remarkably fine job. I am not criticizing the Commission. I am criticizing the law. The law should clearly be restricted to the weapons field as far as secrets go.

Senator BRICKER. When you are criticizing the law you are criticizing the Congress for what they have enacted. Congress has authorized the declassification of all information that is not detrimental to our national defense. Where are you going to put the authority to say what is dangerous to the national defense if not in the Commission itself? There isn't a member of this committee or a Member of Congress that I know of who doesn't want all the information available that is possible in the hands of teachers, scientists, and such people everywhere, but we don't want to imperil the national defense. I think we ought to be careful of going beyond what the Commission advises is a proper field of protection.

If the law doesn't give the Commission enough authority, it ought to be pointed out to us, but in my judgment we have given the Commission all the authority they need to declassify anything they want to except in the field of weapons and military defense.

Mr. KENYON. Senator, I didn't mean to criticize the Congress. I think——

Senator BRICKER. You criticize the law and Congress enacted the law.

Mr. KENYON. Yes. Because times change. I say that now the law should be changed. It has gotten to the danger point. It has carried us through the situations during the war and during the earlier postwar period admirably. I am all in favor of it. But now a change

is needed. We are facing these trade situations and the development of industries which we have not faced before, and we are suffering because of secrecy.

Let me interject there that the reason why you cannot get foreign patents is that if an American application is filed it is put under secrecy and you are not permitted to file it abroad. Obviously if you filed that application abroad you would be transmitting secret information to the foreign country, and that is not permitted. So the secrecy provision is the fundamental problem about foreign patents. If you get rid of this secrecy restriction, industrialists can file foreign applications abroad and protect themselves as they do in other industries.

Senator BRICKER. Do you find other countries freer with their information than we are?

Mr. KENYON. I think they are. You know vastly more about that than I do. I think some of them have restricted information because they know they can't do business with the United States unless they, by bilateral agreements, agree to maintain information secret. Apart from that I am inclined to think they are not as strict as we are, but I am not a witness on that score.

Shall I proceed with the statement?

Representative HOLIFIELD. Go ahead, Mr. Kenyon.

Senator BRICKER. Maybe we should not have broken in.

Mr. KENYON. There was a second part of your question which I have forgotten and I would like to come to it.

Senator BRICKER. Where the authority as to what should and should not be declassified ought to be placed.

Mr. KENYON. Here is the point: You said last that what you wanted to do was in every way to encourage the dissemination of everything that did not relate to weapons. That is precisely what I am asking for.

Senator BRICKER. And national defense.

Mr. KENYON. National defense. I agree with you that it is hard to draw the line, but the law does not draw the line there. The law restricts data much more sweepingly.

Section 11r has three sections. The first section relates to atomic weapons, the second section to the production of nuclear materials or special materials, the third to the use of special material in atomic energy. The second and third are not limited to weapons, and I am asking that those sections be eliminated and that the secrets be limited, just as you indicated they should be, to the weapons field.

Senator BRICKER. I didn't say the weapons field. I included there the security of the country. We have now put that in the hands of the Commission and I don't know any place else that you could lodge it.

Mr. KENYON. Then I will take issue with you, sir, and urge that the secrecy restrictions be limited to the weapons field. If I may go ahead to give my reasons for it.

I do quote the McKinney panel, but you are familiar with their statement that "As long as any atomic information remains under control, those interested in its development and application will suffer serious handicaps."

So I pass to the four reasons which I have indicated here which lead me to believe that the secrecy restrictions should be eliminated.

First, the secrecy provisions concentrate economic power and the vast resources of experience and knowledge, gained at public expense, in the hands of relatively few.

By operation of the present law, the "restricted data," which the American people have spent billions of dollars in accumulating, is available only to the Commission and its staff, to the operators of its facilities and to the small group of contractors and licensees who have gained admission to the program. Of the hundreds of thousands of firms and individuals who would be potential contributors to the atomic program if our constitutional heritage of free speech and freedom of the press were applicable to it as to other sciences, only 1,145 access permits to firms and individuals were in active status last month, according to the Atomic Industry Reporter, January 16, 1957.

Representative COLE. May I interrupt? Do you know of a single instance where an applicant for an access permit has been denied access to secret information?

Mr. KENYON. I am seeking to be cleared myself. It is a long and laborious program. I have gotten my slip back for the third time to get proper fingerprints. I have to make a statement that I will never divulge any restricted data to anybody. I simply state this to indicate what I and all the other members of my firm are going through in order to be in a position to represent clients who may have problems in atomic science.

There is so much redtape, there is so much that you have to go through in order to get any information and to get yourself in a position where you may apply, that I am frank to say I don't know anybody who has been denied access to information if he could show that he was qualified for it, but it is a long, hard fight to get yourself qualified.

Representative COLE. What is the longest period of time to your knowledge?

Mr. KENYON. I know of no other that has been longer than our own case. We have 11 members of our firm, and we have been at it for the better part of this year. The FBI people were around investigating me this week.

Representative COLE. You mean 6 weeks' time?

Mr. KENYON. I am sorry, last year. It has been months. I am sure we started it last summer.

Most of the trouble has been on our side because of all the papers that had to be prepared and all of the fingerprinting and those long questionnaires.

Representative COLE. And so many people.

Mr. KENYON. And so many people, that is true. I haven't a bit of criticism of the Commission, the staff, everybody connected with it. I think they have done and are doing a magnificent job. I have never met people more dedicated and hard working in their service than the Commission staff with whom I have had the privilege of working on matters of this character. I think they are doing excellently. Again I say my difficulty is with the law which imposes all this redtape and the requirements that you have to go through to get access to all this material when you should be able to publish it and talk about it and freely exchange information as we do in every other science, and not be tied up.

Representative COLE. Don't you recognize that the use of atomic energy or special nuclear material has a direct relationship to our national security?

Mr. KENYON. I do.

Representative COLE. That is one of the elements you would have eliminated from the law.

Mr. KENYON. I recognize that it has a profound relationship to our national defense and security. If we do not develop atomic science and keep in the leadership, I think that our safety and security will be greatly endangered. If we have these restrictions outside of the weapons field, I do not see how our atomic science is going to keep pace with the development in foreign countries. Of course I recognize what you are saying, that if we let these secrets out we benefit the enemy. I recognize that. But my thesis is that we have come to the point where whatever secrets we have left—and we may have a lot less than we think—are not worth the price that is being imposed upon the development of the atomic industry in the United States.

That is really the problem that you gentlemen must determine. I am an outsider. All I know is from a lifetime of experience in watching the growth of industry and knowing that the exchange of information is the lifeblood of technical progress. Patents, by bringing things into the public domain, are just a part of it. That has been my life. Here we have a science in which as the Commission filters these things out and declassifies them after the demand has been made, not before, they for the first time become not only available to scientists but subject to discussion by scientists.

Shall I proceed?

Representative HOLIFIELD. Yes.

Mr. KENYON. The second point on page 5: The secrecy provisions vest discretionary power in the Commission to insure or to destroy the economic future, in atomic development, of firms competing for position in the atomic program.

No business organization can take an important part in atomic development without applying to the Commission for clearance and access to restricted data. The Commission is faced with the task of doling out its secret information to individual applicants in such a way first as to maintain security, and second, to promote progress. Inevitably it must select and reject applications on a fine line of distinction by the exercise of its discretion. In choosing firms identically situated it can destroy the economic future of one while clothing the other with experience and knowledge of inestimable value.

Mr. Harold P. Green, recently of the Office of General Counsel of the Atomic Energy Commission, had this to say recently on this very issue:

> Government-imposed restraints upon the flow of information are, in essence, abhorrent. Total restrictions upon access to information have been tolerated in the interests of national security, but restraints unevenly applied as among competing firms are another matter. Access to restricted data is the immediate gateway to the atomic future of American industry. The slightest deviations in equality of access to restricted data may be of the most profound immediate and long-run significance to the economic status of the firm affected, to the relative position of competing firms, and to the basic structure of our future atomic economy. The situation is rendered all the more serious by the Government through application of vague and subjective standards.
>
> The AEC has rushed headlong into the new experiment in information control without full and adequate consideration of its implications. A problem of this

magnitude and novelty, involving not only questions of economic and legal policy and effective security, but also problems of essential freedoms of man, should not be entrusted to the discretion of the Government agency whose gropings for a reasonable solution lead inevitably to questionable decisions which may not be easily rectified in the light of hindsight.

Senator BRICKER. This man formerly held an important Government job. After you have read all this criticism of his, what do you get out of it except that he is not satisfied with what anybody else does?

Mr. KENYON. I think he feels that the secrecy restrictions are contrary to American principles and that they should be eliminated as promptly as possible. He cites this economic problem as an important consequence of the impossible task which has been placed before the Commission by these divergent requirements of law: Freedom on the one hand, restriction on the other. They have to steer both ways at once.

Senator BRICKER. He says:

The AEC has rushed headlong into the new experiment in information control without full and adequate consideration of its implications.

That sounds like everybody is out of step but him. It seems to me where a man has held a job and then gets out and criticizes the ones who employed him—I don't know the purpose of this criticism at all. It is very wordy and you might have to analyze it to see what he is driving at. On the other hand, they don't impress me very much.

Mr. KENYON. I agree with him, but I don't blame the Commission, sir. The Commisison had to do a job in a tremendous hurry. All of us felt the urgency of this thing. I think the Congress did its best in 1954. The Commission has been struggling to do its best ever since. I am simply urging that the rules be changed now so that we can proceed without these difficulties.

Representative COLE. Before you leave that. You were going to say you agreed with Mr. Green?

Mr. KENYON. Yes.

Representative COLE. I doubt that you subscribe to his assertion that the Atomic Energy Commission, as the Government agency, is one "whose gropings for a reasonable solution led inevitably to questionable decisions." Can you cite a single instance where a decision of the Commission with respect to removing an item from the restricted data category has been a questionable decision?

Mr. KENYON. I don't like the word "questionable."

Representative COLE. How do you feel about the word "inevitable"?

Mr. KENYON. I agree with that. I think the system of having to deal with these applications for restricted information leads inevitably to discrimination. It isn't intentional. It is the best that the most qualified man can do under the circumstances, and in the exigencies of the situation. If you have fair competition with full knowledge on the part of everybody, everybody entitled to get his information freely, then you could not criticize a Government bureau for doing the best it could, and inevitably failing to be absolutely perfect.

Third, the secrecy provisions bar American firms from important foreign markets, threatening to make a mockery of our atoms for peace program.

American manufacturers are almost completely barred from normal contact with foreign markets. They must, for the most part, work

through the respective governments involved. Except in Canada and Great Britain they are barred from filing applications for foreign patents to protect their inventions from being pirated by foreign competitors.

Representative COLE. Who barred them?

Mr. KENYON. The secrecy provisions of the law.

Representative COLE. Not the regulations of the foreign government, but ours?

Mr. KENYON. No; it is the law. I may say that I understand from Mr. Roland Anderson that if you go to the Commission and present special circumstances justifying the filing of an application abroad in order to prevent forfeiture of an invention, they will look it over and see whether there is anything in it that they don't want to have transmitted to the foreign government, and even though the corresponding United States application is under secrecy they may permit you to file a foreign application or perhaps file it after making certain deletions. But that is a very enlightened Commission practice. The law doesn't say anything about it. It is the staff which worked out a scheme for trying to minimize forfeiture which happens in most cases.

The Commission is striving through bilateral agreements with foreign nations to give some measure of protection to American manufacturers abroad. But the efforts thus far have failed largely to prevent the forfeiture of American rights and property abroad, forfeiture due entirely to the secrecy provisions of our own law. Only a handful of foreign governments have accepted our bilateral agreements; as many others have turned them down because of the secrecy irritations and misunderstandings involved. (See relevant correspondence, p. 238.)

Senator BRICKER. Do you know of any who have turned them down? There are 41 bilateral agreements in effect and there are 11 pending at the present time.

Mr. KENYON. My information is largely based upon Mr. Anderson's statements to me, Senator Bricker.

Senator BRICKER. Who told you?

Mr. KENYON. Roland Anderson, who is on the staff of the AEC.

Senator BRICKER. This is the testimony of the Chairman of yesterday, that I told you.

Mr. KENYON. That 41 agreements?

Senator BRICKER. That we have 41 bilateral agreements with other countries and that there are 11 pending at the present time, and there are only a few duplications among them. There are not many more nations in the world that would be interested in that or competent to handle a program of this kind if we gave them all the information, are there?

Mr. KENYON. I can only understand Chairman Strauss' testimony or make it consistent with Mr. Anderson's, who handles these things for the Commission, by understanding that all but a few of the bilaterals do not contain these patent exchange protections. I may or may not be right about that. Otherwise I cannot make the two statements consistent.

Representative HOLIFIELD. I think the gentleman is right in his interpretation, because these agreements are not the same kind of agree-

ment with all these different countries. They vary to a great extent. Some of them are very limited.

Senator BRICKER. At the present most of them are research agreements.

Representative HOLIFIELD. They are research agreements.

Mr. KENYON. I am talking about bilateral agreements to protect American trade rights abroad.

Representative HOLIFIELD. Through the exchange of patents?

Mr. KENYON. Through the protection of patents. That is the type I have in mind. As to those it is my understanding, and I may be right, that only a handful of foreign governments have accepted those agreements, as many others have been turned down. These governments are looking elsewhere for engineering and equipment.

Last fall, Mr. Gordon Dean, former Chairman of the Atomic Energy Commission, pointed out the travesty of trying to promote our power-reactor program abroad when the power reactor itself was strictly secret. He said:

> There is only one answer to this. The answer is in a one-sentence, clear-cut declassification of power reactor technology. If we are not willing to take this step, we should never have entered upon an international atoms-for-peace program, and I assure you that if we don't take this step we will never get such a program.

Now, in February 1957, the Commission assures us that information sufficient to build power reactors has been declassified. Industry representatives are frankly skeptical.

I am quoting what they said at the meeting of the American Management Association earlier this month.

But power reactors are only a part of the atomic field, perhaps a small part in the long run. New sciences are utterly unpredictable. The papers last week reported vulcanization of tires by atomic energy. I assume that that is not a power reactor. Restricted research is going forward in the chemical industries, in communications, in food processing, and other fields where men are looking forward.

If Congress really wants to promote this science in 1957 it must now, at this session, make the entire store of information accessible. We cannot wait to release information grudgingly, subject by subject. To do so means that outsiders will continue to be denied the restricted data which might catalyze their development of new industries; insiders will be entrenched by the possession of secrets disclosed to them alone.

Fourth, the secrecy provisions paralyze the teaching and dissemination and normal growth of atomic science in this country by prohibiting free exchange of information.

This is to me the most fundamental danger of them all.

I will skip the next paragraph because I think I have already said the substance of it.

Freedom to publish and exchange information is the foundation on which we have built up our technology brick by brick, each man free to publish the results of his own experiments or thinking, however fragmentary, and to piece together the published reports of others, each stimulating the thinking of others and striving to outdo the rest in the competitive race of progress.

Freedom of speech and of the press is as priceless a heritage in the fields of science as it is in politics, in government, in education, or any

other activity vital to a free society. Without freedom to publish and exchange information, science cannot grow but must wither. Restraints on such freedom, as by the secrecy provisions of the atomic energy law, threaten to destroy the progress of atomic science in America.

I assume that the proposed section 145c of the 1953 bill was not enacted because it was supposed that we then possessed atomic secrets so important that we must suffer, for their protection, a regime of rigid secrecy and restrictions upon our whole technology outside the charmed circle of the Commission and its satellites.

Representative COLE. On that point, Mr. Kenyon, what is the difference whether you require by law the Commission to declassify within a period of 3 years, or permit them to declassify, unless you can show that the Commission has failed to reach one decision or another within the 3-year period?

What is the difference?

Mr. KENYON. I think the difference is fundamental, Congressman Cole. You Congressmen have the responsibility for deciding whether American industry is to have this material or not. If you delegate it to a Commission, in the very nature of government that Commission is bound to be cautious to make sure that every single item that comes before it can never be criticized as having been improvidently declassified by some subsequent investigating committee of Congress. It is a terribly serious burden and responsibility that you are putting upon the shoulders of these men, and I pay them the highest tribute. I think they are trying desperately to do it. But the history of what has happened demonstrates that these things are declassified only as they are called for. You don't get the forward look, the imagination, the progress from the declassified material. They have now grudgingly declassified power reactors.

Representative COLE. Why do you say "grudgingly"?

Mr. KENYON. Because it has come out so slowly. I apologize for it grudgingly because it is not what I mean. It has come out bit by bit. It has been the result of the Commission's realizing that these things had to be declassified in order to permit the work to go on.

Representative COLE. You say it has been coming out bit by bit, which doesn't square with the expression that the general manager made yesterday in which he said that industry is complaining that it is coming too fast.

Mr. KENYON. The exchange of information is a matter of stimulus. If it is coming at them too fast, I say fine. It is true it is coming faster. As I said earlier, at first it was released by spoonfuls, more recently by shovelfuls. But I come back to my point that it should be the Congress of the United States which takes on its shoulders the responsibility for making the decision that all information that doesn't have to do with weapons shall be made available to the public and that no commission can ever be expected to do that job fast enough to solve the vital problem which is facing us here and abroad.

I think I have said my say. The last page of my paper merely repeats the statements that I have made, that knowingly the price that we are paying and must pay if secrecy is to continue, the issue is squarely before you whether there is greater security in continued secrecy or in full application of the power of free enterprise.

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Senator BRICKER. Let me say to you that you have completely overlooked one of the matters that was constantly considered by the committee and by the Congress and a very real consideration in the final drafting of the law, and that is the public safety. The peaceful uses of this terrible power—and it is terrible for it has the possibility of destroying the world and all society—peaceful uses could be dangerous to society. There are many fields in which it no doubt would be dangerous unless it is carefully guarded. At all times this committee, and I think everybody will agree with me, was extremely careful that the public safety be considered at every turn. We put that responsibility on the Atomic Energy Commission. I don't want to see a pellmell program, one attempting to get ahead of the other in the field—North American, General Electric, whatever it might be—without thorough and adequate protection to the public. After all, that is similarly our responsibility.

Mr. KENYON. I could not agree with you more, Senator.

Senator BRICKER. That is a matter of secrecy in many respects.

Mr. KENYON. No. Let me say that I think for public health and safety the American scientists who are not presently admitted to this program may have something of enormous value to contribute if the matters are put before them. By what right do you think the Atomic Energy Commission and the small group of people who are admitted to this thing are the only ones or even the best ones to solve questions of public health and safety? Don't you think there are a great many others outside who could——

Senator BRICKER. I don't know that any body who ever had anything constructive to contribute, either in the field of industrial development or the development of the military weapons or the protection of the public, has been denied the right to present that and to work in the field. In fact, the Commission is having trouble at the present time, and it has emphasized almost daily in the public press that there are not enough people available in the program. We had that testimony in the international program, that we could not afford to give up the number of scientists in this country in the field which would be necessary to carry out the full protection of the public if we went wholeheartedly without any restraints at all.

I myself can't see but that there has been free dissemination of the information which is available. How did we get this program, how did we vulcanize rubber, how did we do all these things that you mentioned in your statement if we are stifling the program, if free enterprise is not working, if creative ability is not being put to play in this program?

Mr. KENYON. Of course the Goodyear people must have applied to the Commission and gotten the right to do this work. Otherwise they could not have had the material to work with. They may have supplied all of the information themselves. I don't know the story about that. But I agree with you that the number of people is too small. We should encourage people to get into this work, to think about it. The only way to get them to think about it is to give them the information and permit them to discuss that information, to utter their own original thoughts, to publish their original thoughts, and to tell the Commission if there is any way in which the terrifically serious problems which are holding this thing back can in their judgment be solved. There may be a great solution there.

Senator BRICKER. Let me say to you very frankly that I do not defer to you or anybody else in my support of private enterprise and the free interchange of knowledge and information and the protection of the right of business to be free and conduct its operations as it sees fit without Government interference.

Yet this committee and this Congress have two paramount considerations. The first is the national safety, to develop a military program so as to prevent the outbreak of an atomic or hydrogen war, and to be able to take care of ourselves if one does come.

Second, that the public be adequately protected in the utilization of this force which has possibilities of very grave danger to the country.

Mr. KENYON. I think we are in entire agreement, except that I think that we will reach those conclusions faster if everybody is allowed to think and speak about them.

The CHAIRMAN. Mr. Kenyon, I am sorry that I was not present to hear your entire statement dealing with this program which of course has been a matter of great concern to the committee.

In your statement you seem to place the responsibility on the Congress in which I think I would agree with you. In formulating this whole program from the beginning it was in almost complete secrecy. Even Members of Congress were not permitted to go into it in the days when we first developed it. Then Congress, thinking along somewhat the lines you are thinking, I believe, decided that there was but one way to disseminate this information safely and securely. We adopted a civilian control agency. I am one of those who believes that if we had not done so, we probably would not be here today talking about reactors or any other part of this program. In trying to do that, of course, our whole purpose was to disseminate this information as fast as possible so private industry could take it on and really make progress with it. Today there exists a private industry. There is not a free exchange of patents yet by private industry in this country. There is not a free exchange of patent rights, which are more or less classified as secret by individuals and private owners. This is correct, is it not?

Mr. KENYON. I am sure there is no free exchange of patents. I haven't heard of anything of that sort.

The CHAIRMAN. When the Government owns it of course it is a little bit different, but the principle is very much the same. I think what we have already done has been to progress, in my opinion.

Mr. KENYON. I agree with you.

The CHAIRMAN. I believe the Congress has full confidence in the Commission. We are trying to disseminate this information without lifting the whole thing overnight. I don't see how we could do that today. The thing is so involved with the actual development in the weapons field, which you agreed should of course have necessary security.

Mr. KENYON. I think when a secrecy program of this sort interferes profoundly with the teaching of the science, with the development of engineers, with the bringing of new brains, imagination, and capacity into this field, it is high time that Congress weigh the importance of the secrets which are left against the handicap which it is imposing upon the ordinary forces of the free enterprise system in the further development of atomic science and figure out which is more important.

The CHAIRMAN. Thank you very much, Mr. Kenyon, we appreciate your coming here.

(The correspondence referred to on p. 233, follows:)

ATOMIC ENERGY COMMISSION,
Washington, D. C., February 27, 1957.

THEODORE S. KENYON, ESQ.,
Kenyon & Kenyon,
New York, N. Y.

MY DEAR MR. KENYON: Your testimony of February 20 before the Joint Committee on Atomic Energy of the Congress of the United States has been read with interest.

At page 331 (hearings, p. 233) of the transcript in a colloquy with the Honorable John W. Bricker, Senator from Ohio, you ascribe to me the furnishing to you of the information that "only a handful of foreign governments have accepted our bilateral agreements; as many others have turned them down because of secrecy irritation and misunderstandings involved" and that I handle such matters. The following statement is made in refutation thereof.

First, I do not recall ever making such a statement as you attribute to me. In fact, I am not aware of any such basis of rejection of bilateral agreements.

Second, I do not handle the negotiation of foreign bilateral agreements, so that I would not be in position to have knowledge of the basis of rejection by any foreign government.

A copy of this letter is being sent to the Joint Committee on Atomic Energy of the Congress so that the record may stand corrected as respects your attributing the above statement to me.

Sincerely yours,

s/ROLAND A. ANDERSON,
Chief, Patent Branch.

KENYON & KENYON,
New York, N. Y., March 1, 1957.

MR. ROLAND A. ANDERSON,
Chief, Patent Branch, United States Atomic Energy Commission,
Washington, D. C.

DEAR MR. ANDERSON: I have your letter of February 27, 1957, and am glad you have set the record straight.

You have been of such outstanding assistance in supplying information at various meetings I have attended and in correcting misapprehensions on the part of those who have been working to improve the law and promote the progress of atomic science, that I am particularly sorry to have named you as authority for information I must have gained elsewhere.

On reconsideration I realize that I should have referred to Mr. Gordon Dean's remarks before the Institute of the Michigan Law School held at Ann Arbor last September to consider legal problems of atomic energy (see pp. 96 and 97 of the reprint of proceedings). There he referred to the restrictions on dissemination of power reactor technology in our bilateral agreements, and in accounting for the small number of such agreements said:

"* * * all these make for irritations and misunderstandings in a program that was originally conceived as eliminating irritations and bringing about understanding.

"This has had the effect of turning people in foreign countries away from the United States and it accounts in some part for the organization of Euratom in Europe and for interchanges between foreign countries other than the United States. Most of the countries of Western Europe are today turning to the United Kingdom and to each other. India turns to Canada, and so on down the line."

I may add, that in commending, at the hearing on February 20, the high order of ability and dedication to service of the members of the Atomic Energy Commission staff, I had principally in mind Mr. Roland A. Anderson.

I appreciate your letter and am glad to have this opportunity to correct the record, for which purpose a copy of this letter is being sent to the Joint Committee on Atomic Energy of the Congress.

Very truly yours,

THEODORE S. KENYON.

The CHAIRMAN. The next witness is Mr. Graves.

STATEMENT OF EBEN GRAVES, CHAIRMAN, ATOMIC ENERGY COMMITTEE, NEW YORK PATENT LAW ASSOCIATION

The CHAIRMAN. Mr. Graves, you have a written statement and you may proceed.

Mr. GRAVES. My name is Eben Graves. I am senior member of the firm of Brumbaugh, Free, Graves & Donohue, and have been connected with it or its predecessors for nearly 30 years. We specialize in patent matters and patent litigation.

I have the privilege of being the chairman of the Committee on Atomic Energy of the New York Patent Law Association. The board of governors of that association have instructed me to appear here today to present the substance of a resolution of the board for the amendment of the Atomic Energy Act of 1954, particularly as set forth in H. R. 600, and to submit for your consideration certain brief comments directed to their position in this matter.

Representatives of the New York Patent Law Association have several times in the past appeared before or submitted statements to your committee or its predecessor committees relative to the 1946 Atomic Energy Act and the 1954 act, always with the objective and firm belief that as fully and promptly as possible, patent matters in the atomic energy field should be brought within and controlled by the existing body of patent law and patent statutes.

The rationale of this belief is that by so doing the declared policy of the Atomic Energy Act of 1954 best can be carried out. That policy is set forth in the first section of the act:

> It is therefore declared to be the policy of the United States that * * * (b) the development, use and control of atomic energy shall be directed so as to promote world peace, improve the general welfare, increase the standard of living, and strengthen free competition in private enterprise (ch. I, sec. 1, declaration (b)).

I believe it has been established beyond dispute that the workings of our patent system by its balance of incentive reward and publication have strengthened free competition in private enterprise, increased the standard of living and thus the general welfare. As a result, world peace has been promoted, albeit indirectly.

It is the belief of the Board of Governors of the New York Patent Law Association that the 1954 Atomic Energy Act contains several provisions that in philosophy and operation are in opposition to factors which have made our patent system such a successful part of our economic system. It is our belief that the amendments to the act proposed in H. R. 600 are a most important and essential first step in carrying out the declared policy expressed in the opening statement of the act, and thus a strong first step in bringing the 1954 Atomic Energy Act into agreement with our national economic policy.

In view of this, the board of governors of the New York Patent Law Association, and I may add the Atomic Energy Committee of that Association, unanimously endorse and approve the amendments to the Atomic Energy Act of 1954 set forth in H. R. 600 introduced by Representative Sterling Cole January 3, 1957, and strongly urge that H. R. 600 be enacted as promptly as possible by the 85th Congress.

I believe it is important to comment on certain of the provisions of the 1954 act which have given our association as well as many other lawyer groups considerable concern. For example, the Constitution

of the United States requires that the inventor receive the patent. However, the first sentence of section 152 of the act as it now stands runs contrary to the Constitution in that it provides that the Commission "shall be deemed to have made or conceived" the invention This device to provide for control by the Commission is not necessary in any event, for the Commission can obtain title to those patents to which it is entitled by express or implied contract relations, such as is done, for example, in contracts with the Defense Department. H. R. 600 provides for the elimination of this first sentence of section 152.

H. R. 600 also improves section 152 as to what inventions may be subject to acquisition by the Commission by clarifying the meaning of the controversial phrase "arrangement or other relationship" with the Commission. This definition is so broad and vague as to cast a shadow on the title of inventions developed by those who have had only a remote connection with the Commission. H. R. 600 clarifies these provisions in the 1954 Act so as to limit the Commission's right to acquire only those inventions involved as the result of a contract "express or implied, entered into with the Commission for the benefit of the Commission." This amendment is clear, definitive and understandable.

Section 153 of the 1954 Act provides in effect for the compulsory licensing for the benefit of either the Government or private enterprise of any patent for "the production or utilization of special nuclear material or atomic energy." By its terms, the section applies only to applications filed prior to September 1, 1959. Actually this cutoff date is more apparent than real. The application filed prior to September 1, 1959, may not issue as a patent for several years after that date, possibly because it is under security or secrecy provisions, and when issued and for 17 years thereafter always would be under the threat of compulsory license.

The constitutionality of section 153 is certainly questionable for, by it, the power of the Federal Government to condemn property for its own use is extended to the condemnation, in effect, of private property for the use of private citizens.

An even more serious criticism of section 153 is that it undermines a most vital factor in making operative our patent system, and that is incentive. The atomic field is so highly speculative, the cost of entering the field in time and money proportionately so great with respect to the capacity of a given company, that many companies would expect to get no return except for the possibility of patent rights which, because they extend for 17 years, might pay off ultimately. The Commission, following the procedure of section 153, may direct that these patent rights must be shared with others by compulsory license. The incentive to create in the atomic field is thereby lost. With no publication by patenting, and thus no knowledge to stimulate further creative efforts by others, different and better inventions for the public welfare are not forthcoming.

The bludgenoning threat of compulsory license is certainly not justified by the possibility sometimes advanced that a patent might issue would strangle an industry. There is no historical basis indicating that such a strangulation situation might ever exist. An attempt to overreach by use of a patent merely stimulates invention to find a different and better process or device to accomplish the same end.

Representative HOLIFIELD. At this point, Mr. Graves, I would like to speak to you about the situation that existed at the time this law was passed. We were dealing in a field where the United States Government had spent around $12 billion of the taxpayers' money developing the atomic art. We were dealing with a situation which never existed before in the United States. Never to my knowledge had the Government spent any such sum or anywhere near that sum, from its complete inception through the period of development until 1954, the state at which the art had then arrived, a complete art, a new science, new technology, new methods, new gadgetry.

There had been a limited participation until that time by a few great companies. You could count them almost on one hand. If we had applied at that time an open door under the regular American patent practice, those 4 or 5 companies could have taken advantage of their knowledge of the art and undoubtedly they could have moved in and patented processes, techniques, and gadgetry which would have been worth many hundreds of millions and possibly billions of dollars to them in the years to come. They could have thrown a stranglehold on the dissemination of knowledge and practices at that time, and we would have given away the heritage of the American people, which they had paid for with their tax money, not to the public at large which was entitled to the result of the expenditure of tax moneys, but we would have given it away to the few people who had the advantage of participating in the program under contracts with the Government and having been paid at least their expenses for their activities for the Government.

So we were defrauding no one at that time and we are protecting the American people from being defrauded. That was why those laws were passed. I think most of the members of this committee believe in the patent laws which obtain under ordinary circumstances, but we thought we had a public trust. At that time, and to a certain extent some of that public trust still remains.

When it gets to the point where there is general dissemination of this knowledge, particularly in very critical fields, to the point where it is no longer a matter of defending the public trust, I think all of us will be glad to get rid of the restrictive patent laws of which you complain. Can't you put yourself in our position for a moment as being trustees of a science which has been paid for with tax moneys and realize that we had a problem?

Mr. GRAVES. I certainly appreciate that you had a problem.

Representative HOLIFIELD. The only way we knew how to handle it was to make compulsory patenting during a certain length of time, a certain time during which we hoped the knowledge would be widely and freely disseminated to all comers. During that period it would have been unfair to have allowed any of these big companies to patent a segment of the art or a peculiar process. Then by royalties or by the complete refusal to allow them to use their patents, which is permissible under normal patent law, they could have accrued to themselves great advantages, and great disadvantages would have resulted to their competitors who had not been fortunate enough to participate in the program.

That is why these laws were passed.

Mr. GRAVES. The problem of the Atomic Energy Commission under these statutes was not unique. It is true it spent more money. All

through the early part of the war under defense contracts we were exploring many fields which at the time were just as interesting as atomic energy.

In many of those contracts part of the incentive to stimulate these developments was the contractual right given for civilian uses of these things. The Government would have of course all the weapons. In the atomic energy program of course you had special problems. You had secrecy problems far above anything else. At the time radar looked about as secret as could be, but the atomic program went well beyond that.

Representative HOLIFIELD. At least you couldn't take the secret of radar and destroy a city with it.

Mr. GRAVES. That is right. You say it would have been unfair. Again that is a matter of judgment. What is going to be for the ultimate good of the public? Is it for the ultimate good of the public to allow some contractors to make a return on their creative efforts?

Remember, many of these services in the Manhattan project were far above the call of duty of an ordinary contract.

Representative HOLIFIELD. I won't agree with you on that. I think when we are engaged in a war a corporation has just as much of an obligation to preserve the continuity of the environment in which they operate as an individual has.

Mr. GRAVES. I think that is true and I think that was demonstrated.

Representative HOLIFIELD. I think no corporation participated in the war effort beyond the call of duty. Most of them were rewarded handsomely by it.

Mr. GRAVES. They were rewarded, but they were not necessarily rewarded unfairly. That was the word that you used.

Representative HOLIFIELD. That is a matter of opinion as to whether some of them were rewarded unfairly or not. We could go into that to a considerable extent and see these companies which have built up hundreds of millions of dollars worth of capital investment out of defense contracts. While my brother and possibly your brother were over there giving their lives for this country and for 80 bucks a month. So I would not retreat from my position.

Mr. GRAVES. That is quite a different question, the renegotiation of contracts, in which I am not skilled or prepared to answer. What I am saying is that you may feel these companies may have these rewards improperly. The balance is, are we justified in using a system to stop them from getting those rewards which destroys incentives and where the public is going to be harmed?

Representative HOLIFIELD. I don't think that we are, and I don't know that that has happened because in the 11 years that this art has been in the public domain—it should be more than 11 years if you go back to where we first started the Manhattan project—we have made wonderful progress. We have made it in a time of war as well as in a time of peace. The art is becoming better known and information is being disseminated. Today there may be 500 companies that are participating to some extent where there were only 5 or 10 participating before. You are getting the knowledge disseminated to the point that I think we have to look at the patent situation.

Mr. GRAVES. By subcontracting it spreads out.

Representative HOLIFIELD. I agree with you on that. I still think that the Congress has discharged its public trust in a manner for which they have no apology by enacting the law that they put through at that time.

Mr. GRAVES. I think the recommendations that we are making are very closely tied up with the transition period which you are now going forward with, the tremendous declassification which came on at the Geneva Conference. Of course that was a great step forward. There are many areas now in which you can properly operate on foreign information. The Atomic Energy Commission is not the fountainhead of all knowledge. As you know, there are a number of foreign patents which have come up, filed before the Atomic Energy Commission was even in existence.

Representative HOLIFIELD. I certainly agree with you that American industry at this time is put in a very unfair position in competition with foreign industry in this field of patent protection. I certainly agree with you on that.

Mr. GRAVES. Shall I go on?

The CHAIRMAN. Proceed, please.

Mr. GRAVES. I also call to your attention the fact that such strangulation is blocking off by patent can exist only by leave of our Federal courts acting on the equity side, that is to say, through the issuance of an injunction in an infringement suit. We do not have to search the cases too long to appreciate full well that the public interest is always a factor which the courts weigh in granting or denying such injunctions. This is a part of our common law heritage and does not require legislative approval. It has been the controlling factor in motivating the courts in refusing injunctions in the so-called "misuse" cases. It was also the motivating factor in such cases as the activated sludge case where even in the absence of misuse but in the face of clear findings that the plaintiff's patent was valid and had been infringed, injunctive relief was refused as not being in the public interest.

That case concerned the sewage-disposal process of a municipality. The court was asked to issue an injunction. They clearly infringed a patent which was valid, and did not wish to shut down the sewage system. The court found it was not in the public interest to do it and denied injunctive relief. It shows the courts acting in equity consider these matters. On this issue therefore we hold firmly to the conviction that on such matters as are within the purview of section 153's provisions for compulsory license, we should avoid legislation which runs contrary to our overall national policy and rely on our courts to apply the principles of our common law in the public interest.

Compulsory licensing is not required to prevent the creating of a monopoly by a combination of patents, for the courts relying on the antitrust statutes have met and overcome that problem many times.

We strongly endorse H. R. 600 because it would repeal the undesirable compulsory license provisions of the act and also would repeal related section 154 which provides injunctive protection for those operating under some subdivisions of section 153.

Section 155 of the act is likewise controversial. It is contrary to established patent law and procedures because it makes subject matter under the secrecy provisions of the act effective as prior art. H. R. 600 provides an improvement in this situation in that it would require

that such material to be a bar must, at least, be published by the Technical Information Service of the Commission. As such it is still classified. However, this is a step in the right direction.

The other portions of H. R. 600 are desirable but of an order which would not require special comment at this time.

Finally, short of elimination of all restrictions bearing on the normal application of patent law to atomic science (except for restrictions as to weapons, assuming they cannot be handled in the same manner as are developments for the Defense Department), we believe a revision of the section referred to above, as provided by H. R. 600 is a forward step. It gives to the field of atomic science additional established advantages of the patent system, and thus tends to fulfill the declared policy of the Atomic Energy Commission of improving the general welfare, increasing the standard of living, strengthening free competition in private enterprise, and so promoting world peace.

The CHAIRMAN. Thank you very much, Mr. Graves, for taking your time to present your views.

It is one of the problems that we face, and we shall continue to make a study of it and try to improve it in the best interests of the American public.

Mr. GRAVES. Thank you.

The CHAIRMAN. The committee is in recess until tomorrow at 10 o'clock in room F–41 of the Capitol.

(Whereupon, at 5 p. m. Wednesday, February 20, 1957, the committee was recessed, to reconvene at 10 a. m. Thursday, February 21, 1957.)

DEVELOPMENT, GROWTH, AND STATE OF THE ATOMIC ENERGY INDUSTRY

THURSDAY, FEBRUARY 21, 1957

CONGRESS OF THE UNITED STATES,
JOINT COMMITTEE ON ATOMIC ENERGY,
Washington, D. C.

The committee met at 10 a. m., pursuant to recess, in room F–41, the Capitol, Hon. Carl T. Durham (chairman of the Joint Committee) presiding.

Present: Representatives Durham (presiding) and Kilday; Senators Pastore, Gore, and Dworshak.

Also present: James T. Ramey, Executive Director; George E. Brown, Jr., David R. Toll, professional members of the staff, and George Norris, Jr., committee counsel.

The CHAIRMAN. The committee will come to order.

This is a continuation of the testimony of the industrial groups throughout the country. Our first witness this morning is Mr. Donald M. Ballou, of the gas and electric department of the city of Holyoke, Mass. We are glad to have you with us this morning, Mr. Ballou. You may proceed with your statement.

STATEMENT OF DONALD M. BALLOU, NUCLEAR PROJECT OFFICER, GAS AND ELECTRIC DEPARTMENT, CITY OF HOLYOKE, MASS.

Mr. BALLOU. My name is Donald M. Ballou. I am the superintendent of the gas division of the city of Holyoke, Mass., gas and electric department, and the nuclear project officer of that department.

Gentlemen, this statement is in response to your invitation issued by letter dated January 18, 1957.

We hope that an account of our experiences and problems in connection with our recent proposal to the Atomic Energy Commission will be of assistance to the committee.

This department was one of seven proposers in the second round of the reactor demonstration program. We proposed the construction of a gas-cooled reactor coupled with a closed-cycle gas turbine for power production purposes. Our proposal was rejected by the Atomic Energy Commission on January 2, 1957.

This department decided to participate in the reactor demonstration program when the second round of that program was first announced in September of 1955, based on the following considerations:

(1) We are located in one of the high fuel cost areas of the United States and are therefore in an area where nuclear power is first apt to become economically competitive.

(2) We are a municipality producing our own power in city-owned generating facilities and are necessarily interested in small generating units (up to 15,000 kilowatts), the area requested in the second-round invitation.

(3) Our studies indicated that our normal expected load growth is such that a plant of the size contemplated could be efficiently integrated into our system in the course of normal expansion.

(4) We have a completely integrated system with load characteristics and distribution problems which could probably be classed as typical for plants of our size, and which would, therefore, be well suited for demonstration purposes.

REACTOR SELECTED

After considerable study and after consultation with numerous reactor manufacturers, this Department decided to propose construction of a gas-cooled reactor coupled with a closed-cycle gas turbine, for the following reasons:

1. Research and development: It had been our understanding from the beginning that the Atomic Energy Commission was most interested in proposals contemplating construction of advanced type of reactors since such proposals would be most likely to advance reactor technology. A gas-cooled reactor appeared to fulfill this criterion.

2. High efficiency: The design of the plant proposed contemplated the direct use of the coolant (nitrogen or helium) as the driving medium in the turbine, thereby eliminating temperature loss in a heat exchanger, resulting in high efficiency.

3. Low cost: Since the design of the plant proposed required no heat exchanger or no coolant pump (the turbine acting as the coolant pump for the system), the plant gave promise of having an ultimately low capital cost.

4. Safety: The type of plant proposed has certain features which should result in inherent safety in operation. In the event of an accidental release of the coolant there would be no phase change and no chemical reaction. This would result in a comparatively low volume of released materials and thus simplify the containment problem. Furthermore, because of a low nuclear cross section, the coolant gas itself would contain little or no radioactivity.

5. Compact design: The plant as contemplated would be small in size and compact in design. Such a plant should be ideal for export purposes, and it was, therefore, considered that development of such a plant would be of great interest to the Atomic Energy Commission, and fulfill the needs of the second-round reactor demonstration program.

PROBLEMS ENCOUNTERED

In developing our proposal we encountered several problems and made some observations which we shall attempt to summarize as follows:

(1) The greatest single problem that we encountered was the requirement of the Atomic Energy Commission that the proposer submit a "closed-end" proposal. This requirement proved very difficult to fulfill for the following reasons:

(*a*) In the beginning we found manufacturers understandably reluctant to quote fixed prices on equipment and installation.

(*b*) We found it impossible to obtain firm commitments of costs of fuel fabrication, reprocessing, and transportation.

(*c*) We found it impossible to obtain firm commitments of cost of insurance, not only in the third party liability field but also in the fields of direct plant insurance and workman's compensation.

(*d*) Due to lack of certain experimental data it was impossible to determine the life expectancy of the fuel elements contemplated for this plant.

(*e*) As a municipality we had no risk capital for research purposes as such.

This particular problem was finally resolved by submission of a "phased" proposal. Briefly stated, it was proposed that the overall contract be divided into several phases to allow solution of the technical problems as they arose with a minimum commitment on the part of AEC as well as on the part of the proposer.

For example, the first phase of the program contemplated conducting certain experiments by our coproposer, Sperry-Rand Corp., Ford Instrument Division. Sperry-Rand agreed to conduct these experiments on a fixed maximum cost basis, to assume the "open end" in the event the costs exceeded the agreed maximum, and to construct certain required experimental facilities at its own expense in order to conduct such experiments. A continuation of the project was then made contingent on successful completion of the first phase to the satisfaction of all of the parties.

The proposal as finally submitted contained several contingencies, but we were given to understand that it met the criterion of a "closed-end" proposal, to the satisfaction of the Atomic Energy Commission.

(2) We encountered the problem of the unavailability of third party liability insurance coverage. This problem is still not resolved but we proceeded on the assumption that the efforts being expended by this committee and by others in this field would result in a solution. We still hope that such will be the case.

In this regard we requested Government indemnity of a contractual nature. This was intended as an alternative to an adequate solution of the insurance problem. In this regard, however, some doubt was expressed by our legal counsel as to the effectiveness of such an indemnity agreement in view of the provisions of section 53–e–8 of the Atomic Energy Act of 1954 which provides for indemnity of Government by licensees.

(3) The problem of site selection was anticipated but never became an issue. We had several potential sites for the construction of the proposed plant and one of the contingencies of our proposal was that one of our proposed sites be approved by the Reactor Safeguards Committee of the AEC. We anticipated that in the event our proposal was accepted as a basis for negotiations one of our first steps would be to obtain at least preliminary approval of one of the proposed sites.

In this connection we would like to note our opinion that small nuclear powerplants are likely to become economically feasible only if they can be constructed within reasonable transmission distance of the community that they are intended to serve.

(4) We encountered no problems in obtaining an access permit and clearances for our own personnel. To the point where we progressed in the program we did not find the classification of information to be a major handicap.

(5) The reason given for the ultimate rejection of our proposal was "the Commission determined that the planning of a powerplant based on the proposed reactor system is premature because the basic feasibility of the concept has not yet been demonstrated."

Quite frankly, this objection came as a surprise since at no time had we been advised that this feature of our proposal constituted a major objection to its acceptance. On the contrary, as stated above, we had been led to understand that the Atomic Energy Commission would look most favorably on proposals for plants of advanced design.

At our first meeting with the Selection Board in March of 1956 one member of the Board suggested that our proposal might be better adapted to some future program of the Commission. The point was discussed briefly, no conclusion was reached, and although we were thereafter in frequent communication with the Commission staff, the issue was never again raised until we were notified of the rejection of our proposal.

We mention our difficulty in this regard because we believe it points up one problem which might tend to discourage future proposers, but which could be easily remedied. We believe that the staff of the Atomic Energy Commission should attempt to maintain a closer liaison with proposers in order to facilitate coordination of the aims of the proposer with the aims of the Commission.

CONCLUSIONS AND RECOMMENDATIONS

On the basis of our own experiences and on the basis of what facts we were able to learn in the course of our participation, it is our opinion that the reactor demonstration program has not proved successful.

The program has now been in existence for about 2 years. In that time there have been 10 proposals, one contract, and no construction. It is significant, we think, that the one contract which has been executed contemplates the construction of a pressurized water reactor. This is the type of reactor of which the most is known as a result of governmental research, development, and construction.

The basic difficulty we think, stems from the fact that the program requires the assumption of large and undetermined risks by individual private companies. A private company can only justify assumption of such a risk if it can demonstrate at least the possibility of a reasonable gain in the event the enterprise proves successful. However, the nature of the atomic energy industry is such that the principal gains to be realized from a successful enterprise will react to the benefit of the industry as a whole rather than to the benefit of the individual. Under the circumstances, private interests are naturally and understandably reluctant to assume risk ventures, which, if successful, will benefit their competitors as much as themselves. This difficulty applies with equal force to potential manufacturers of reactors, of fuel elements, and of auxiliary equipment, as well as to utilities.

This conclusion is confirmed, we believe by the poll reported on January 29, 1957, by the Atomic Industrial Forum that in the opinion of the American atomic industry "Lack of economic incentive is regarded as by far the major obstacle to the development of atomic energy for peaceful purposes."

It is therefore our opinion that if the public interest requires, as we believe it does, a rapid development of nuclear power, the development and demonstration should be done by the Government at Government expense, and Congress should make funds available and see that the program is carried to completion.

We do not believe that the recently announced third round of the reactor demonstration program is likely to prove any more successful than the two rounds which have gone before. On the contrary, it appears from the criteria issued by the AEC that the difficulties encountered by proposers in the first two rounds will be magnified in the third round, at least in the case of small plants. We base this opinion on the fact that proposers under the third round will apparently be required to assume all capital costs of the plant without assistance in this area from AEC. This can only result in increased risks to the proposers, with no greater hope of individual gain being offered. The problem will if anything be greater than before.

It is our opinion that the concept of the gas-cooled reactors should be developed and demonstrated as quickly as possible. This opinion is based on what we believe to be the inherent possibilities of this concept as outlined above. We understand that the staff of the Atomic Energy Commission do not disagree with our conclusions as to the probable advantages of gas-cooled reactors. (See also statement of Dr. Farrington Daniels, chairman, chemistry department, University of Wisconsin, which appears in "Accelerating Civilian Reactor Program." Joint Committee hearings, 84th Congress, May 23–29, 1956, p. 221, in which he states: "I would advocate a 5,000 kv. unit built right away without further laboratory work.")

In the foregoing paragraphs we have attempted to outline some of the problems which we encountered and the opinions which we formed in the course of our dealings with the Atomic Energy Commisison with regard to our proposal. If the committee should desire that we amplify any of the points discussed above, or if the committee should desire any information which we might have relative to some point not discussed above, we will be most happy to respond.

We would like once again to express our pleasure at being given the opportunity to make this statement and to further express our willingness to cooperate in any way possible toward the successful completion of the committee's objectives.

The CHAIRMAN. Thank you very much, Mr. Ballou.

Did the AEC know at the time you filed your application what type of reactor you were trying to build?

Mr. BALLOU. Yes, sir.

The CHAIRMAN. They were fully informed of that?

Mr. BALLOU. We presented a full technical description of the reactor, and that description has never been changed.

The CHAIRMAN. You made your application on what date?

Mr. BALLOU. On February 1, 1956.

The CHAIRMAN. Then you have spent about a year?

Mr. BALLOU. We spent about a year trying to meet the criteria of the Commission.

The CHAIRMAN. Do you have any estimate of the cost to your city?

Mr. BALLOU. The last estimate I have is about $8,000.

The CHAIRMAN. You spent $8,000 and got nowhere?

Mr. BALLOU. Got nowhere, exactly.

The CHAIRMAN. I also notice that you point out some of the difficulties you encountered along the line. There has not been a prototype of this type of reactor in operation yet, but the idea has been advanced in England and has been successful.

Mr. BALLOU. Calder Hall is a gas-cooled reactor.

The CHAIRMAN. This was designed by what company?

Mr. BALLOU. The Ford Instrument Division of Sperry-Rand Corp.

The CHAIRMAN. Senator Gore?

Senator GORE. Could you not resubmit your application under the third round?

Mr. BALLOU. We have studied our application for possible adaptation in the third round, but we feel that with lack of capital participation by the Commission in the construction of the reactor it would be impossible for us to go ahead.

Senator GORE. I remember that statement as a part of your prepared statement, but as I understood the third round, about the only thing excluded from capital participation would be brick and mortar.

Mr. BALLOU. Hardware.

Senator GORE. From the statements of the Chairman of the Commission, I did not understand that there was excluded from capital participation by the Commission very much of the really expensive part of the reactor.

Mr. BALLOU. As we visualize this third round assistance, the assistance will be granted in the form of research and development grants. They state specifically that they will not bear any part of capital costs of the plant.

Senator GORE. Yes, but did you happen to read the statement of Admiral Strauss which he made in December? Do we happen to have a copy of that here? December 8, I believe it was.

(Off the record.)

Senator GORE. We will come to that. If you have a copy of the testimony of the other day when Admiral Strauss was testifying, I quoted a paragraph from that speech. I will go to another point and then we will come back to that.

I notice you recommend that the gas cooled reactor be constructed. Is that a prototype or large scale?

Mr. BALLOU. We think that a program should be inaugurated which will result in the actual construction of a powerplant reactor.

Senator GORE. What is your opinion of the project at Idaho on which preliminary work is now underway by Aerojet? Is that gas cooled?

Mr. BALLOU. That is gas cooled, sir. I believe that our coproposer could better answer you on this point. We understand that this is an experimental-type reactor which is concerned primarily with military problems.

Senator GORE. Not primarily with civilian power.

Mr. BALLOU. That is merely my understanding, sir. I can't vouch for the accuracy of it.

Senator GORE. That is being constructed for the Government under an Aerojet contract with the Government for that construction.

Mr. BALLOU. That is our understanding, sir.

Senator GORE. Do you know of any exploration of a new concept of reactor technology which has been undertaken by a private industry

prior to some technological development and exploration by the Commission itself?

Mr. BALLOU. I have never heard of such a concept in practice, sir.

The CHAIRMAN. If the Senator will yield at this point, I would like to ask if you made it perfectly plain to the Commission what type of reactor you were going to build when you made your application?

Mr. BALLOU. Yes, sir.

The CHAIRMAN. They knew it was a gas-cooled type?

Mr. BALLOU. Yes.

The CHAIRMAN. On what date in 1956 was the reason given for the turning down?

Mr. BALLOU. January 2, 1957.

The CHAIRMAN. In other words, from the beginning you wanted to build a gas-type reactor?

Mr. BALLOU. Yes, sir.

The CHAIRMAN. And 1 year later they told you it was not feasible?

Mr. BALLOU. We were aware of the technical problems involved in a gas-cooled reactor and we took into account those problems in our proposal by phasing the proposal. We suggested that a certain amount of research and development work be done.

The CHAIRMAN. Of course if it was turned down for lack of a prototype, we didn't have one in 1956 and we don't have one in 1957.

Mr. BALLOU. That is right, sir.

The CHAIRMAN. So why couldn't they have turned it down and saved the $8,000?

Mr. BALLOU. That point is very well taken, sir.

Senator GORE. It would have been worth some $8,000 to you if it had been rejected earlier?

Mr. BALLOU. That is right, if the decision had been made immediately it would have saved us that much money. We received a liberal education in return for our $8,000, however.

Senator GORE. On the basis of that, your recommendation to this committee is that the Government proceed with the reactor-development program forthwith?

Mr. BALLOU. Which will result in the development of a gas-cooled reactor for power use, wherever it may be. We believe the reactor concept has much merit and, if you will, a crash program should be undertaken to bring it to realization.

The CHAIRMAN. It would appear to me that having a prototype or not having a prototype had nothing to do with the decision. It was known that we did not have a prototype. So if we were going to turn it down on the basis that we did not have a prototype and didn't know enough about it, the decision could have been made when you made the application and you could have gone on about your work.

Mr. BALLOU. I would like to point out one thing and I would not like to have it sound like sour grapes. The Commission did accept one proposal for a reactor of which there is no prototype and which technically is more advanced than the gas-cooled reactor in our opinion, and that is the sodium-deuterium reactor.

The CHAIRMAN. Mr. Kilday.

Representative KILDAY. No, thank you, Mr. Chairman.

Senator GORE. If you don't mind, Mr. Chairman, I have now before me the paragraph from the statement of the Chairman of the Com-

mission, which statement led me to the conclusion that the incentives and aids and assistance of the third round were far and away more generous and encouraging, if not enticing, than either the first or second round. I would like to read this paragraph. Quote:

> There is both need and opportunity to move ahead at an accelerated pace not only in actual construction of full scale experimental and prototype nuclear powerplants, but also in expanding our store of technology by means of more complete research and development. Therefore, I am proposing that the Commission substantially increase the existing opportunities for Government assistance in this respect by assuming a greater share of the cost of research and development as distinct from the actual construction cost. This extension of Government assistance in addition to the Commission's own experimental projects would apply not only to proposals found acceptable under the new third round of the power demonstration program, but also the projects already initiated under the earlier first and second rounds. I am confident that such Government support for research and development will have a highly encouraging effect on the rate of progress of the entire nuclear industry. It will involve—

Now I come to the particular part to which I was referring—

> not alone the design of the reactors themselves, but the improvement of materials, cheaper and longer lived fuel elements, reactor physics, heat-transfer methods, fluid mechanics, chemical processing, waste disposal, reactor safeguards, and many other things that go to make up the broad challenge of cheap, plentiful, and safe nuclear power.

The point I was attempting to make with you, Mr. Ballou, is that if this paragraph from the statement of the Chairman of the Commission is an accurate description of the added assistance, incentives, and encouragement, about all I can see eliminated is the brick and the mortar, which are a relatively minor part of the cost of the reactor.

Mr. BALLOU. I am afraid that we do not necessarily agree with the admiral there. We have no risk capital as such to construct a reactor. We can only spend that amount of money which we could spend for a conventional power-producing unit, if you will. We cannot go beyond that capital cost.

Senator GORE. In any event, as I understand you, your application was not turned down on any of these grounds.

Mr. BALLOU. No, sir.

Senator GORE. But on the ground that no prototype——

Mr. BALLOU. The basic feasibility had not been demonstrated.

Senator GORE. Thank you, Mr. Chairman.

The CHAIRMAN. I hold in my hand a statement which was sent in by the Ford Instrument Co., a division of Sperry-Rand Corp. Speaking of the lack of experience in this field, they say:

> After several years of study we have concluded that a system using a gas-cooled reactor offers one of the best means of furnishing energy which would be competitive with normal fuels in combination with a closed-cycle gas turbine utilizing the same reactor-gas coolant.

They participated in a lot of our research and development work along with the nuclear power reactor and many other projects.

Mr. BALLOU. That is right. We were very careful in choosing our coproposer.

The CHAIRMAN. It was not just a lack of experience here?

Mr. BALLOU. No, sir; I don't believe so.

The CHAIRMAN. It wasn't that at all.

Mr. BALLOU. We were very careful in choosing our reactor manufacturer.

The CHAIRMAN. They had been accepted many times by the AEC to do this type of work on reactors?

Mr. BALLOU. That is right, sir.

The CHAIRMAN. Senator Dworshak.

Senator DWORSHAK. Mr. Ballou, in your statement you said:

> It is therefore our opinion that if the public interest requires, as we believe it does, a rapid development of nuclear power, the development and demonstration should be done by the Government at Government expense, and Congress should make funds available and see that the program is carried to completion.

How would you apply that suggestion to your own local situation? What do you want us to infer from that?

Mr. BALLOU. We have no selfish motive here, sir. We believe that the Gore bill as originally proposed would have been the best means of accomplishing the development of civilian power by means of reactors. Regardless of the site, whether they are located in city or town or an atomic-energy facility our recommendation is that actual construction of the powerplant and the operation of it should be by the Government itself.

Senator DWORSHAK. In your case you think that the Congress should provide funds for the Commission to actually construct a plant and then make it available for operation in your community?

Mr. BALLOU. No, sir; that is not our recommendation.

Senator DWORSHAK. Will you clarify it a little bit? I want to be sure I understand you.

Mr. BALLOU. We are taking a broad viewpoint, I believe. We feel that if we are ever to have a nuclear powerplant available for us, that we can buy with our own funds, this prototype must be built and operating experience gained. We feel that the only way it is going to be done is to have the Government build it somewhere and get the operating experience and establish the capital costs, and then we can go ahead and buy it as we would a conventional plant.

Senator DWORSHAK. You are implying that the Government merely should provide a prototype and the research and development but not actually construct plants which might subsequently become available to use?

Mr. BALLOU. No, sir. I believe it is clear that we recommend that the Government build and operate these plants at its own expense.

Senator DWORSHAK. Just a single plant, a demonstration plant?

Mr. BALLOU. A demonstration plant.

Senator DWORSHAK. And in this case because there has not been a prototype you thought that would be a very appropriate place to have a demonstration plant?

Mr. BALLOU. In the second round invitation it seemed that we could help the Commission as well as the Commission could help us. In our original proposal, which was filed in February of 1956, we offered to invest the equivalent amount of money that a conventional plant would cost us and pay the equivalent amount of money in operating the plant that we would for a conventional plant, but that was termed unacceptable by the Commission.

Senator DWORSHAK. That would be virtually a joint venture.

Mr. BALLOU. That is correct.

Senator GORE. Mr. Chairman.

The CHAIRMAN. Senator Gore.

Senator GORE. As I understand your position, it is that you think the development of economic atomic power can be brought about in a reasonable time only by the Government itself demonstrating the feasibility and successful method of construction and operation of an atomic powerplant.

Mr. BALLOU. That is 100 percent correct.

Senator GORE. You, as a public utility executive, take the view, then, that such an act on the part of the Government would open the door for the construction and operation of such a plant by the city of Holyoke, Mass.

Mr. BALLOU. That is right.

Senator GORE. Now let me ask you if you think that this would be a boon and an advantage and open the door of opportunity to your utility, why would not that be true of a private utility?

Mr. BALLOU. It certainly would, sir.

Senator GORE. Thank you. That calls for a statement on my part. I have viewed this proposal as being one of the greatest boons to private enterprise. Once a successful economic means of constructing, operating, and generating atomic power has been demonstrated, then atomic power will blossom and bloom under the auspices and profitable operation of private enterprise. Until that is demonstrated, private enterprise will continue under pressure and continue to lose money, and the American people will continue to suffer the tardiness of atomic power development.

Mr. BALLOU. I agree with you, sir. The only really true free competitive enterprise system in the utility business is the manufacturer, and he is the one who is suffering at the present time.

Senator GORE. The manufacturing business which would supply to you, if you were to buy a reactor, the parts, the instrumentation, the generators, et cetera, is identically the same manufacturing industry that would supply them to Consolidated Edison or to the Pacific Edison or whatever private concern wanted to buy a reactor.

Mr. BALLOU. That is right.

Senator GORE. The utility concerns, whether public or private, are not in the business of manufacturing reactor parts, generator parts, or indeed parts of any sort.

Mr. BALLOU. That is right. They are interested in buying them at the best price possible.

Senator GORE. If the Government demonstrates the feasibility and economic advantage of this, then not only will the manufacturing industry benefit, but the utility industry, whether public or private, will vastly benefit and the public likewise.

Mr. BALLOU. That is our feeling.

Senator GORE. Thank you, Mr. Chairman.

The CHAIRMAN. Mr. Ballou, on page 3 of your statement you state "The greatest single problem to be encountered was the requirement of the Atomic Energy Commission that the proposal submit a closed-end proposal," a fixed price.

Do you think that the main reason for rejection of your proposal was that you could not meet that requirement, or was it the very fact that there was no guide or protoype of the gas-cooled reactor? Do you feel that the chief objection of the AEC and its reason for turning down your proposal was the fact that you could not have a fixed price on the parts, the reactors and everything else?

Mr. BALLOU. I will say that that was the problem in the beginning, but as our proposal was finally revised and finally sent to the Commission we had fixed closed-end prices. We gave them not only closed-end prices, we gave them maximum-cost prices. In other words, the opportunity was there for negotiation downward.

We had a maximum fixed price established for all phases of our proposal. We had the proposal broken down into three distinct phases—the preconstruction research and development which had a fixed maximum cost price tag, the construction phase which had a fixed maximum price tag, and the postconstruction research and development period which also had a fixed-price tag. So we met fully the criteria of the Commission in this regard. There was no objection on the part of the Commission to that particular point.

The CHAIRMAN. Where did that put the risk?

Mr. BALLOU. It put the risk on the Ford Instrument Co. and the city of Holyoke, if you will.

The CHAIRMAN. In other words, they assumed all the risk for the whole design and completion of the reactor.

Mr. BALLOU. That is right, sir. If I may say, the Ford Instrument Co. stood ready to protect the city of Holyoke.

The CHAIRMAN. Mr. Kilday?

Representative KILDAY. No questions.

The CHAIRMAN. Thank you very much, Mr. Ballou.

(The Ford Instrument Co. statement and pertinent correspondence with the AEC regarding the Holyoke proposal follow:)

STATEMENT PREPARED FOR THE STATUTORY HEARINGS OF THE JOINT COMMITTEE ON ATOMIC ENERGY BY THE FORD INSTRUMENT CO. DIVISION, SPERRY RAND CORP.

In response to an invitation of the Joint Committee on Atomic Energy, it is our pleasure to respond with a statement concerning our views on the progress and on the needs of industry in order to accelerate the progress in the development of nuclear energy for peaceful uses.

Ford Instrument Co., a division of the Sperry Rand Corp., employs at the present time approximately 2,800 people. The company's main activity since its founding in 1915 has been the design, development, and manufacture of controls, computers, and instruments for use by agencies of the Defense Department and, more recently, the Atomic Energy Commission. In 1953, we established a nuclear engineering department which has been engaged in the development and manufacture of reactor instrumentation and controls and in engineering studies of new reactor systems.

After several years of study, we have concluded that a system using a gas-cooled reactor offered one of the best means of furnishing energy which would be competitive with normal fuels and, in combination with a closed cycle gas turbine utilizing the same reactor gas coolant, would provide an economical, efficient, simple, and safe power system. While such a system would be restricted for the present to installations supplying between 5,000 and 30,000 kilowatts of electrical energy due to current design limitations in turbine size, there would be in our opinion be innumerable applications for a power unit of this size in ship propulsion, remote military installations, high-cost fuel areas in this country, and in almost all other areas in the world where large powerplants are impractical because of lack of power distribution networks.

We have also concluded that, using an efficient plant of this type, essentially automatic, a series of units spaced around a large municipality or across a sparse area would probably prove more economical and would certainly minimize the vulnerability to attack now presented by extensive interlocking networks depending upon large central stations.

Our engineering studies to date demonstrate the theoretical feasibility of the gas-cooled reactor system, and at the same time have indicated areas where considerable experimentation is required in order to demonstrate the practicability of the system. Such experimentation, as well as the research and development work required to demonstrate the feasibility of the entire system, requires the expenditure of considerable sums of money, the investment of a great amount of engineering time and effort, use of facilities, some of which are not available at present, and, upon completion of the research phases, construction and operation of a pilot plant. The cost to carry out the full program, estimated at over $10 million, is beyond that which an individual company would ordinarily be able to bear. Furthermore it is our understanding that it is the policy of the Atomic Energy Commission to sponsor research into just such areas of general application as this, since the results of a successful program on the gas-cooled reactor system would provide broad benefits to commerce and industry both at home and abroad.

Some progress has been made. We have received modest support from the Commission in sponsoring further studies of the gas-cooled reactor system. The Commission has also undertaken the program known as the gas-cooled reactor experiment, a program devoted largely to experimentation in the lower power ranges for the specific requirements of certain military applications. This program will undoubtedly furnish certain valuable data in the future.

There are, however, many additional areas requiring exploration and proving out in order to demonstrate the feasibility of a power generating system, using the gas-cooled reactor, closed cycle turbine system in the area of more efficient and economical operation, in considerably higher power capacities.

We believe, therefore, that full-scale program of research and development can and should be undertaken with the immediate objective of advancing the solution of problems in a gas-cooled reactor system. Such a program was proposed to the Commission, under its second round reactor demonstration program, jointly by the city of Holyoke, Mass., and Ford Instrument Co., and included an offer to provide, at our expense, the special facilities, not now available, which are necessary in order to conduct certain phases of development on the gas-cooled reactor system. This proposal was rejected on the basis that the technical feasibility of the proposed plant would be contingent on the resolution of certain basic questions.

Representatives of the Commission have stated that there are at present insufficient funds to allocate to an expanded research and development program for the gas-cooled reactor power system. It is our understanding that support is available under the second and third round demonstration programs for research and development work on projects which are to result in construction, within a defined time limit, of specific generating plants, but that support for experimentation aimed at demonstrating the feasibility—or lack of feasibility—of a potentally valuable system not yet advanced enough to justify the obligating of actual plant construction is restricted by existing fund limitations. While there has been considerable interest in this country and abroad in the status and progress of our work in the gas-cooled reactor system, neither we nor anyone else are as yet in a position to guarantee the feasibility of plant operation prior to completion of a program of experimental work.

We believe it is the intention of Congress that the Atomic Energy Commission should encourage progress in peaceful uses of nuclear energy by sponsoring research and development in new and improved reactor systems, with industry participating by significant contributions of manpower, equipment, and some facilities. We therefore believe that the Congress should make funds available to the Commission which will permit them to accomplish this end, without the requirement for actual commitments for construction of plants until an advanced type of reactor has been proven feasible by research and development. With Government support for feasibility proof, we believe there will be adequate industry acceptance of the risk involved in construction and operation of such plants, contingent only upon Government indemnity for liabilities beyond available insurance limits.

FORD INSTRUMENT CO.,
DIVISION OF SPERRY RAND CORP.,
RAYMOND F. JAHN, *President.*

LONG ISLAND CITY, N. Y., *February 18, 1957.*

MARCH 2, 1957.

Mr. K. E. FIELDS,
General Manager, United States Atomic Energy Commission,
Washington, D. C.

DEAR MR. FIELDS: Mr. Durham asked me to request the Commission's comments on a telegram we recently received from the city of Holyoke, Mass., gas and electric department, which stated as follows:

"It is understood that Dr. Davis, Director of Reactor Development, has stated in testimony before your committee in response to a question by you that AEC cannot see its way clear to committing itself to constructing a plant where there are so many test problems and uncertainties involved. The Director of Reactor Development of AEC apparently does not understand the terms of the Holyoke proposal. The Holyoke proposal does not require any such commitment until test problems and uncertainties are satisfactorily resolved."

It would be appreciated if you would arrange for appropriate Commission representatives to review Mr. Ballou's testimony and the statement by the Ford Instrument Division of Sperry-Rand, together with comments by Commission representatives during the 202 hearings with a view to explaining or reconsidering the Commission's action on the Holyoke proposal.

Sincerely yours,

JAMES T. RAMEY, *Executive Director.*

ATOMIC ENERGY COMMISSION,
Washington, D. C., March 22, 1957.

Mr. JAMES T. RAMEY,
Executive Director, Joint Committee on Atomic Energy,
Congress of the United States.

DEAR MR. RAMEY: Reference is made to your letter of March 2, 1957, requesting further explanation of the Commission's action on the proposal from Holyoke and the Ford Instrument Division of Sperry-Rand under the Commisison's power demonstration reactor program. The telegram from the city of Holyoke quoted in your letter noted that the proposal did not require a commitment to construct a plant until test problems and uncertainties are satisfactorily resolved.

The primary purpose of the power demonstration part of the Commission's civilian power reactor program is to stimulate industrial participation in the application of nuclear power technology. A reasonable amount of research and development is considered justifiable in connection with nuclear power demonstration projects. This supporting research and development should be for the purpose of providing engineering design data, developing and testing major components, and improving the economics of the nuclear plant performance. It is not considered appropriate to enter into these projects when they involve major questions of technical feasibility to be resolved in a supporting research and development effort. There are more satisfactory and, we believe, more logical and workable ways of conducting research and development of this type.

Obviously, there is a judgment factor involved in evaluating technical feasibility and timeliness of projects proposed under the power demonstration reactor program. In this connection, it may be helpful to review specific action taken on proposals received by the Commission and considered along with the Holyoke-Ford Instrument Co. proposal. This is done in the attached table.

To summarize, it was and still is our conclusion that the reactor concept included in the Holyoke proposal represented numerous technical uncertainties of a nature and degree to render it inadvisable to make any present arrangements, either of a firm or contingent nature, leading to construction and operation of a demonstration plant. It is our belief that the best course is rather to carry out present plans for exploration of high-temperature gas-cooled reactor problems by means of the gas-cooled reactor experiment and other research and development efforts within our current program. Mr. Davis' testimony referred to by the city of Holyoke telegram was based on this conclusion.

I trust the above discussion will be of assistance to you.

Sincerely yours,

K. E. FIELDS, *General Manager.*

Commission action on power demonstration reactor proposals

Proposer	Reactor type	Commission action as announced	Comments
RCPA	Boiling water	"* * * approved in principle, as a basis for negotiations, the nuclear powerplant proposals of the Rural Cooperative Power Association * * * and the Wolverine Electric Cooperative * * *"	Technical feasibility of boiling water concept well established by BORAX at NRTS. Construction on EBWR was in advanced stages at time of Commission action and offered further backup on development of technology.
Wolverine Electric Cooperative.	Single region homogeneous		Technical feasibility of solution type homogeneous reactors was demonstrated by HRE No. 1. Construction of HRE No. 2 was nearly complete at time of Commission action.
Piqua, Ohio	Organic moderated and cooled.	"* * * authorized the negotiation of contract provisions for initial design and development work related to the nuclear powerplant project proposed by the city of Piqua, Ohio * * *" "* * * authorized modifications and extension of its concontract with North American Aviation, Inc., under which the company is designing, developing, and constructing an organic-moderated reactor experiment to be operated at the National Reactor Testing Station near Idaho Falls, Idaho. The contract extension will be for development of reactor components, including a fuel element, for the Piqua project and other preconstruction research and development work. "* * * authorized negotiation of a contract with the city of Piqua which would make it possible to proceed with other phases of the proposal calling for construction and operation of the plant, provided results of the research and development work justify continuation of the project.	There is no question of basic technical feasibility of this design concept. This rate of decomposition of the organic material is an unknown which could have important effects on the plant performance and economics. The OMRE is designed to supplement other radiation damage experiments in providing information on this factor. OMRE fabrication was in progress when the Commission action was taken. Decision was to expand research and development effort already in progress, including work on specific plant components, and to provide basis for future construction based on expectation of favorable results from OMRE early in 1957.
Chugach Electric Association and Nuclear Development Corporation of America.	Sodium cooled D_2O moderated.	"* * * approved the negotiation of a contract for limited initial design on a unique nuclear powerplant system as a result of a joint proposal by the Chugach Electric Association and the Nuclear Development Corporation of America * * *." "* * * authorized negotiations of contract provisions which would make it possible to proceed with other phases of the proposal calling for final development and engineering design, construction, and operation of the plant, provided results of completed phases justify continuation of the project."	The principal technical question involved in this reactor concept is one of mechanical design for protection against a serious chemical reaction between sodium and heavy water. Extensive sodium technology is available and is being developed as the result of other projects (SIR, SRE, EBR 1 and 2). Extensive water technology also is being derived from both military and civilian power reactor projects. Decision was that design concept looked sufficiently attractive to warrant initiation of further development and evaluation on a limited scale. No work on the design problems unique to this concept was being supported by the Commission at the time of this action. Establishing a framework for proceeding with other phases of the project in the future is based upon economic advantage of the high-cost power area offered and upon probability of successful solution of design problem.
Holyoke, Mass., and Ford Instrument.	High temperature gas cooled reactor coupled to a gas	"* * * determined that the planning of a powerplant based on the proposed reactor system is premature be-	Commission interest in high temperature gas-cooled reactors is evidenced in the decision to build a gas-cooled

Holyoke, Mass., and Ford Instrument.	High temperature gas cooled reactor coupled to a gas turbine.	"* * * determined that the planning of a powerplant based on the proposed reactor system is premature because the basic feasibility of the concept has not yet been demonstrated."	Commission interest in high temperature gas-cooled reactors is evidenced in the decision to build a gas-cooled reactor experiment. Aerojet General Nucleonics was selected as the contractor for this project after careful consideration of many candidates, including Ford Instrument. The gas-cooled reactor experiment is in early planning stages and completion of the project is perhaps 4 years away. Major material problems have yet to be solved. The gas-cooled reactor experiment and its supporting research and development will provide only part of the answers, but this program appears to provide a good nucleus for planning and possible expansion of the research and development effort. There is less confidence in the timing, cost estimates, and probability of solving the technical problems than in the case of the projects listed above.

Our next witness is Mr. Elmer L. Lindseth, representing the Edison Electric Institute. You may he seated and proceed with your statement, Mr. Lindseth.

STATEMENT OF ELMER L. LINDSETH, VICE CHAIRMAN, COMMITTEE ON ATOMIC POWER, EDISON ELECTRIC INSTITUTE

Mr. LINDSETH. My name is Elmer L. Lindseth. I am president of the Cleveland Electric Illuminating Co., vice chairman of the Edison Electric Institute Committee on Atomic Power and a past president of the institute.

I am appearing here today on behalf of the institute in response to the invitation of the Joint Committee. Chairman Durham's invitation for a representative of the institute to present its views at these hearings on the development, state, and growth of the atomic energy industry is greatly appreciated in view of the vital interest which the institute as a body, and its member companies, who serve 75 percent of the Nation's electric users, have in these matters.

This statement has been authorized by the Edison Electric Institute committee on atomic power which comprises 14 member company executives. The names and business affiliations of the members of the committee are appended to this statement.

The unique genius of the American economy under free enterprise has given the United States undisputed world leadership in electric power production over many decades, utilizing every available energy source. Electric utility companies have a long record of reducing the cost of their service to the public through development of new methods and processes and improved efficiency of operation. The industry today employs every available means in order to continue this long-term trend for the benefit of our customers. To this end we believe that development of nuclear power is a logical extension of our continuing endeavor to provide electricity in abundance at the lowest possible price. The present program of nuclear development, involving expenditure of hundreds of millions of dollars, exemplifies this continuing endeavor.

During the past year substantial progress has been made in the development of nuclear power. Since the Joint Committee is to receive statements from representatives of most of our industry groups or companies sponsoring projects for the development of nuclear plants, we shall not in this statement attempt to review progress made on a particular plant or on specific technical problems but rather will limit our comments to the overall industry picture.

At the time of our committee's last presentation before the Joint Committee in May of 1956, 44 electric power companies and associated service organizations had announced plans for development and construction of 9 nuclear powerplants ranging in size from 3,000 to 236,000 kilowatts of capacity. Their participation was in one of three ways: 2 projects were going forward under the AEC 5-year reactor development program, 2 under the power demonstration reactor program and 5 for development on a straight license basis.

Since last May and up to last week three additional companies or groups of companies had announced plans for the development and construction of nuclear powerplants.

In October 1956, Carolinas-Virginia Nuclear Power Associates, Inc., consisting of 4 utilities in the area, announced its intention to construct a nuclear powerplant or plants.

In December 1956, the New England Electric System, which is a sponsor of the Yankee Atomic Electric Co. as well as Atomic Power Development Associates, Inc., announced plans to construct a 200,000 kilowatt (electric) nuclear powerplant in its service area with completion schedule in 1964.

Earlier this month a group of utilities in Minnesota, Wisconsin, Missouri, North and South Dakota, and Iowa announced that it is undertaking a nuclear powerplant with electric capacity of 60,000 kilowatts on the system of Northern States Power Co.

This week 2 other companies or groups of companies have indicated their intention to proceed with reactor projects. An Ohio Valley group, consisting of 12 companies, announced that it intends to submit a proposal for the comprehensive development of an advanced reactor concept, including the construction of a prototype reactor with heat output of 50,000 kilowatts. Pacific Gas & Electric Co. announced that it intends, either alone or in partnership with other California investor-owned electric utility companies, to submit a proposal under the AEC third round invitation involving a large-scale advance-type pressurized water or boiling water reactor electric powerplant.

These 5 undertakings announced in recent months bring to 14 the number of reactor projects in which electric power companies are participating. These projects, in which 69 companies are participating, are expected to have an electric capacity in excess of 1,500,000 kilowatts and involve expenditures of over $400 million of investor funds.

As shown in appendix A, 7 of these are either under construction or in the immediate preconstruction phase. As indicated in appendix B, 7 are in various stages of planning.

In addition, Middle South Utilities, Inc., and its 4 operating subsidiaries, Arkansas Power & Light Co., Louisiana Power & Light Co., Mississippi Power & Light Co., and New Orleans Public Service Inc., have informed the AEC that they are conducting investigations of the feasibility of constructing a nuclear plant in their service area.

In selecting reactors for development and construction the electric power companies or groups of companies continue to be guided by the very basic consideration that development and construction of the reactor selected should make a significant contribution toward the ultimate achievement of commercial utilization of nuclear power. It is the opinion of the individual companies that commercial utilization of nuclear power best can be achieved through development and construction at this time of a number of different reactor types and variations. This is because of the belief that it is not possible to make a determination now as to which reactor type or types ultimately will prove most advantageous for commercial use. Therefore, the present broad program entails the development of a number of different basic reactor types, plus variations and improvements of certain of those types.

At present, large-scale demonstration projects are under construction or in an advanced stage of planning for 4 of the reactor types that were included in the AEC's original 5-year program; namely, the pressurized water reactor, the boiling water reactor, the sodium-graphite reactor, and the fast-breeder reactor.

In announcing its third round power demonstration reactor program, the AEC stated that progress in the technology of two other types of reactors is such that construction of additional large-scale demonstration projects of those types presently is warranted and desirable. These are the natural-uranium heavy-water moderated reactor and the fluid fuel reactor system. An aqueous homogeneous reactor of the latter types has been the subject of a joint research and development project since July 1955 by Pennsylvania Power & Light Co. and Westinghouse Electric Corp., and is being studied for a large-scale demonstration.

A natural-uranium heavy-water-moderated reactor in large size is being studied as to feasibility by the Florida nuclear power group, and a heavy-water-moderated reactor which either would use natural-uranium fuel or would be a prototype for a large-scale natural-uranium reactor, among other reactor types, is being studied by Middle South Utilities, Inc.

These developments are mentioned in order to emphasize that power companies are making every effort to respond to the AEC's invitation for nuclear powerplant proposals.

Power companies also are cognizant of that part of the AEC's third-round announcement that invites proposals for other types of reactors, including those that represent variations of designs for currently active projects. We feel that our broad goal, namely, that each undertaking makes a significant contribution toward achievement of ultimate commercial utilization of nuclear power, can best be met through development and construction both of variations of types already being developed and more advanced reactor types not yet undertaken.

It may be desirable to develop and construct small-scale reactors of promising types without turbine generator facilities, at least initially. Omitting the turbine generator facilities from prototype projects of most reactor types does not in any sense impair the technical contributions which can be derived from design, construction, and operation of such reactor types. Substantial advances in reactor technology already have been made through construction and operation of experimental power reactors, with no electric output, by the AEC.

A number of companies in our industry are studying advanced designs of nuclear power reactors. We expect that these activities will expand. Three organizations whose research and development work exemplifies our industry's activity in this field are Atomic Power Development Associates, Inc., which is supported by 33 electric power companies and 12 other business organizations, Nuclear Power Group supported by 7 electric power companies and 1 other business organization, and the recently formed Ohio Valley Group made up of 12 companies.

In September of last year the Edison Electric Institute organized a technical appraisal task force on nuclear power. Inasmuch as the task force is submitting a statement to the Joint Committee for incorporation in the record of these hearings, it is not necessary to reiterate here its membership or purposes. Electric power companies expect to look to this task force, as well as to the AEC and others, for future guidance in carrying out their respective programs of nuclear power development. The technical reports of the task force will be

made available to the Joint Committee, the AEC and others interested in the furthering of nuclear power development.

We would like to emphasize again the need for legislation to provide governmental indemnity with respect to nuclear powerplants in addition to such indemnity insurance as now appears to be available commercially. It is understood that hearings on this subject are to be held at a later date and we would appreciate the opportunity to express our views to you at that time.

The Atomic Energy Act of 1954 contains a preference clause governing the disposal of byproduct energy produced by facilities owned by the United States. As we have indicated to the Joint Committee previously, the Edison Electric Institute favors amendments of the 1954 act so as to provide a nondiscriminatory means for disposal of electric energy to take the place of that now prescribed by section 44. The institute also advocates deletion of the preference clause relating to license applications as contained in the last sentence of section 182 (C) of the Act.

In summary, the past year was one of continued progress and significant expansion of our industry's program of nuclear power development. Present plans of electric power companies, both in construction of nuclear powerplants and in study of advanced reactor concepts, comprise a comprehensive program. As additional opportunities or needs develop we expect that necessary further steps will be taken by our industry, with emphasis on advancing the technology and economices of nuclear power applications.

On behalf of the Edison Electric Institute, its committee on atomic power, and its member companies serving 75 percent of all electric users in the United States, I want to again express appreciation for the invitation to appear here today.

There are then appended to the statement the membership of the committee on atomic power; Appendix A, being a table of seven nuclear powerplants under construction or in the imediate pre-construction phase; Appendix B, a list of seven reactor projects in various planning stages based on published information to date; and Appendix C, comprising lists of the member companies of the several groups sponsoring nuclear projects or plants.

The CHAIRMAN. Without objection these documents will be included in the record.

(The documents referred to follows:)

MEMBERS OF EDISON ELECTRIC INSTITUTE COMMITTEE ON ATOMIC POWER

W. L. Cisler, president, the Detroit Edison Co., Detroit, Mich.
P. A. Fleger, chairman, Duquesne Light Co., Pittsburgh, Pa.
G. M. Gadsby, chairman, Utah Power and Light Co., Salt Lake City, Utah.
A. S. King, president, Northern States Power Co., Minneapolis, Minn.
J. W. McAfee, president, Union Electric Co., St. Louis, Mo.
C. B. McManus, vice chairman, the Southern Co., Atlanta, Ga.
I. L. Moore, president, New England Electric System, Boston, Mass.
C. E. Oakes, president, Pennsylvania Power & Light Co., Allentown, Pa.
R. G. Rincliffe, chairman, Philadelphia Electric Co., Philadelphia, Pa.
H. R. Searing, chairman, Consolidated Edison Company of N. Y., Inc., New York, N. Y.
Philip Sporn, president, American Gas and Electric Co., New York, N. Y.
N. R. Sutherland, president, Pacific Gas and Electric Co., San Francisco, Calif.
Chairman: Edgar H. Dixon, president, Middle South Utilities, Inc., New York, N. Y.
Vice Chairman: E. L. Lindseth, president, the Cleveland Electric Illuminating Co., Cleveland, Ohio.

APPENDIX A

Nuclear power plants—investor-owned electric utilities participation, Feb. 21, 1957 (based on published information)—plants under construction or in immediate preconstruction phase

INDEPENDENT INDUSTRIAL PROGRAM

Organization	Type reactor	Electrical capacity of plant	Location	Estimated cost to organization	In operation by—
1. Consolidated Edison Co. of New York, Inc.	Pressurized water thorium-uranium convertor.	236,000	Indian Point, N. Y.	$55,000,000	1960
2. Commonwealth Edison Co. Nuclear Power Group, Inc.[1]	Boiling water	180,000	Grundy County, Ill.	45,000,000	1960
3. Pacific Gas & Electric Co.	Boiling water prototype for Dresden plant.	3,000	Livermore, Calif.	600,000	1957
AS PART OF AEC POWER DEMONSTRATION REACTOR PROGRAM					
4. Power Reactor Development Co., The Detroit Edison Co.[1]	Fast breeder	100,000	Monroe, Mich.	54,000,000	1960
5. Yankee Atomic Electric Co.[1]	Pressurized water using steel clad uranium oxide fuel elements.	134,000	Rowe, Mass.	34,500,000	1960
PARTICIPATING IN PLANTS BEING CONSTRUCTED PRIMARILY BY AEC AS PART OF ITS 5-YEAR REACTOR DEVELOPMENT PROGRAM					
6. Duquesne Light Co	Pressurized water	60,000	Shippingport, Pa.	15,000,000	1957
7. Southern California Edison Co.	Sodium graphite	7,500	Santa Susanna, Calif.	1,000,000	1957

[1] For companies in group, see Appendix C.

APPENDIX B

APPENDIX B

Reactor projects in various planning stages—Investor-owned electric utilities participation, Feb. 21, 1957 (based on published information)

Organization	Type reactor	Electrical capacity of plant	General location	Estimated cost to organization	In operation by—
1. Carolinas-Virginia Nuclear Power Associates, Inc.[1]	[2]	[2]	Carolinas or Virginia	[2]	[2]
2. Florida Nuclear Power Group [1]	[2]	200,000	Florida	$50,000,000	1962
3. Midwest Group [1]	Boiling water	60,000	Northern States Power Co. service area.	20–25,000,000	1962
4. New England Electric System	[2]	200,000	New England	[2]	1964
5. Pennsylvania Power & Light Co	Aqueous homogeneous	150,000	Eastern Pennsylvania	[2]	1962
6. Ohio Valley Group [1]	Advanced	None	[2]	[2]	1962
7. Pacific Gas & Electric Co	Pressurized water or boiling water	[2]	California	[2]	[2]

[1] For companies in group see appendix C.
[2] Net yet announced.

APPENDIX C

Nuclear Power Group, Inc.:
- American Gas & Electric Service Corp.
- Commonwealth Edison Co.
- Central Illinois Light Co.
- Illinois Power Co.
- Kansas City Power & Light Co.
- Pacific Gas & Electric Co.
- Union Electric Co.

Power Reactor Development Co.:
- Alabama Power Co.
- Central Hudson Gas & Electric Corp.
- Cincinnati Gas & Electric Co.
- Columbus & Southern Ohio Electric Co.
- Consumers Power Co.
- Delaware Power & Light Co.
- Detroit Edison Co.
- Georgia Power Co.
- Gulf Power Co.
- Iowa-Illinois Gas & Electric Co.
- Long Island Lighting Co.
- Mississippi Power Co.
- Philadelphia Electric Co.
- Potomac Electric Power Co.
- Rochester Gas & Electric Corp.
- The Southern Co.
- Toledo Edison Co.
- Wisconsin Electric Power Co.

Yankee Atomic Electric Co.:
- Boston Edison Co.
- Central Maine Power Co.
- Central Vermont Public Service Corp.
- Connecticut Light & Power Co.
- Connecticut Power Co.
- Hartford Electric Light Co.
- Public Service Co. of New Hampshire
- Western Massachusetts Electric Co.
- New England Power Co.
- Cambridge Electric Light Co.
- New Bedford Gas & Edison Light Co.
- Montaup Electric Co.

Carolinas-Virginia Nuclear Power Associates, Inc.:
- Carolina Power & Light Co.
- Duke Power Co.
- South Carolina Electric & Gas Co.
- Virginia Electric & Power Co.

Florida Nuclear Power Group:
- Florida Power Corp.
- Florida Power & Light Co.
- Tampa Electric Co.

Midwest Group:
- Central Electric & Gas Co.
- Iowa Power & Light Co.
- Iowa Southern Utilities Co.
- Interstate Power Co.
- Mississippi Valley Public Service Co.
- Northern States Power Co.
- Northwestern Public Service Co.
- Otter Tail Power Co.
- St. Joseph Light & Power Co.
- Wisconsin Public Service Corp.

Ohio Valley Group:
American Gas & Electric Service Corp.
Cleveland Electric Illuminating Co.
Columbus & Southern Ohio Electric Co.
Dayton Power & Light Co.
Indianapolis Power & Light Co.
Louisville Gas & Electric Co.
Monongahela Power Co.
Potomac Edison Co.
West Penn Power Co.
Ohio Edison Co.
Pennsylvania Power Co.
Southern Indiana Gas & Electric Co.

The CHAIRMAN. That is a very excellent statement and one that is very rosy, Mr. Lindseth, if it is carried out. I suppose people as reputable as the companies you represent are expected and supposed to carry it out, is that correct?

Mr. LINDSETH. Yes, sir. We have 75 years of history in the electric power industry of undertaking difficult engineering projects of substantial size. This differs only in character. We recognize the complexity and difficulty of the problems, to be sure. We are confronted repeatedly in quite conventional construction, whether it be of a powerplant, a transmission line, or an office building, with the inflationary problems of the times, resulting in unanticipated cost increases. We are confronted with construction delays due to unavailability of materials, even of quite conventional kinds. I think we are approaching this problem pretty realistically with regard to its size and difficulty.

The CHAIRMAN. I notice that you raise only two questions about changes in the 1954 act. I suppose you heard the statement of the gentleman just before you, Mr. Ballou, of the many problems that he faces. Would you mind pointing out to the committee some of the major problems that your people are facing. You represent a large group and evidently cover the field pretty thoroughly.

Mr. LINDSETH. With regard to the problems of the industry collectively, in whose behalf I am speaking, the industrywide problems are those stated here and the suggestions for amendment to the act are only those two. With regard to individual projects that might have technical problems, fuel processing problems, fuel charge problems, indemnity problems, safety problems, site location problems there I think probably I am not competent to speak for an individual project. And in view of the fact that for every project, or virtually every project we will either have a representative appear or submit a statement, I would defer to those statements on the individual problems.

The CHAIRMAN. If there was a major block it probably would come to your attention since you head up the institute.

Mr. LINDSETH. Yes, on an industrywide basis.

The CHAIRMAN. I am trying to determine if the act is operating well for industry or not.

Mr. LINDSETH. Our industry has only the suggested changes in the act under which we can proceed and go forward.

The CHAIRMAN. Senator Pastore.

Senator PASTORE. I am slightly at a disadvantage because I came in toward the end of the remarks of the witness. Referring you to page 5, where I came in, in the first paragraph you say, "It may be

desirable to develop and construct small-scale reactors of promising types without turbine generator facilities, at least initially."

How do you feel about building large-scale reactors on these existing facilities of public utility companies as against building reactors at Government installations?

Mr. LINDSETH. Our industry steadfastly favors the building of reactors on the utility systems existing.

Senator PASTORE. For the purpose of the record I would like you to tell us why, because I think that is quite important. Why is it desirable and preferable to do it that way? Do I make my question clear?

Mr. LINDSETH. Yes. First of all, we are businessmen, all of us, and as businessmen we believe in the tranditional pattern which has resulted in the development of this country under free enterprise. We do not envisage atomic power essentially different in its long-range development from the discovery of oil or coal or other major advances in fuel. It is new and different. This country has achieved its present status in the world competition industrially and otherwise under a system which we think has been a successful system. We believe in that system and we suggest no change.

Senator PASTORE. Isn't there another advantage, too, that inasmuch as ultimately this current or this power will have to be distributed by existing facilities, would it not be well if the research and development in reactors grew up together with the research and development which has to take place with relation to transmitting this heat over into turbines, generators and what have you, in existing facilities. Is there any advantage in that respect?

Mr. LINDSETH. With regard to research and development it is not a compelling advantage in view of the fact that the technology of transferring energy in either hot water or steam into electric power is a well-established and well-known technology. Electric generation requires some considerable amount of investment, materials, engineering time, and does place some limitations on the experimental opportunities with the reactor, namely, that if the cycle of operation of the reactor is dictated by the electric generation needs, we may have less opportunity to use it for research and development and experimental needs and to change or alter the reactor if such appears desirable. Likewise, we get to the point of life of the combined assets. Steam turbine generator facilities are inherently long-lived.

Senator PASTORE. Then you have, of course, training of personnel for one or the other.

Mr. LINDSETH. Yes, but the training of personnel for the operation of the turbogenerator is quite secondary in importance to training for the reactor portion.

Senator PASTORE. Why does private industry feel that the preference clause is a deterrent in view of the fact we do have an amendment to the 1954 law favoring high cost areas also? Do I make my question clear?

Mr. LINDSETH. Yes.

Senator PASTORE. Let me premise my question by saying that I was one of those who thought that the preference clause had no place in the 1954 law, but if we were going to have it we had to say something about the high cost areas because I come out of New England

and that certainly is a high cost area. So we did amend the law by adding that feature, too. Doesn't that overcome this obstacle which is cited with reference to the preference clause?

Mr. LINDSETH. Our industry takes no exception to that portion of the act which relates to preference in favor of high cost fuel areas. Our two exceptions relate to the preference granted to public agencies as defined, either as to the sale of power or the granting of licenses. We do not dissent from the other preferences in section 182 relating to the high cost fuel areas.

Senator PASTORE. That is all I have.

The CHAIRMAN. Mr. Kilday.

Representative KILDAY. No questions.

The CHAIRMAN. Senator Gore.

Senator GORE. You are vice chairman of the Edison Electric Institute Committee on Atomic Power?

Mr. LINDSETH. Yes, sir.

Senator GORE. Who is chairman?

Mr. LINDSETH. Mr. Edgar Dixon, president of Middle South Utilities, Inc.

Senator GORE. Is he the same Mr. Dixon who won fame partly through the Dixon-Yates contract?

Mr. LIDNDSETH. He was a partner in the Dixon-Yates contract, yes.

Senator GORE. In your statement today you list seven reactors, is that correct, plants under construction or in immediate preconstruction phase. That is in the exhibit attached to your statement. Am I correct that there are seven?

Mr. LINDSETH. Yes.

Senator GORE. Was your company or the institute with which you are connected a contributor to this full-page advertisement which undertook to mislead the American people with respect to the number of reactors?

Mr. LINDSETH. I think I would disagree with the characterization of the ad that it undertook to mislead the people of America.

Senator GORE. Let's see. Here is a large print. You can read that from where you are, I think: "How America will keep its lead in atomic electric power."

On the other side in still large print, but not as large as the first, "This is the way nations rate in nuclear reactors built or planned. United States of America, 55. Great Britain, 17. Russia, 6. All others, 10."

You list seven this morning as under construction or in preconstruction stage. This ad lists 55 as completed and 35 as building or planned. 55 and 35 add up to 90. Will you explain the difference between 90 and 7?

Mr. LINDSETH. Senator, I am here on behalf of the Edison Electric Instituted. In your question you asked if we paid any part of that, and the answer is no, the Edison Institute did not pay any part of the cost of that ad.

Senator GORE. Did the company with which you are individually associated pay any part of it?

Mr. LINDSETH. Yes. The Cleveland Electric Illuminating Co. is a participant in the electric company's advertising program.

Senator GORE. Then in that capacity will you explain the difference between 90 and 7?

Mr. LINDSETH. I didn't prepare the ad. I didn't participate in its preparation. I do, however, know that there has been a full-scale hearing and discussion before one of the committees of the Congress. There is a complete record on it. I could either submit that record in answer to the question or get an additional one, but I am certainly not authorized by my committee to speak to the ad.

Senator GORE. I will not press it further.

In an entirely different tone and, I hope, attitude, I will ask you the same question that I asked Mr. Ballou from Holyoke, Mass. Would it not be a boon to the industry of which you are a spokesman if the Government should demonstrate the feasability of economic atomic power?

Mr. LINDSETH. Whoever demonstrates that will make a real contribution to power generation in this country—whoever makes the demonstration.

Senator GORE. Then your answer would be yes?

Mr. LINDSETH. It would be.

Senator GORE. That is the point that I have been urging. I have not urged that the Government proceed upon an atomic power generation program to injury the private utility industry. I think it would be one of the greatest boons to the industry, to the people of our country, and to the free world.

We have agreed that it would be a great boon to the utility industry whether private or public. I believe you would also agree that it would be a boon to the entire country to demonstrate this economic source of power.

Mr. LINDSETH. Yes.

Senator GORE. Would you not agree, then, in the context of the cold-war conflict that it would be to the interest of the free world for the free world to first demonstrate and then to have in being a source of atomic energy?

Mr. LINDSETH. Yes, I would agree with you on that.

Senator GORE. If we are agreed there, I solicit your help in bringing about such a program.

Mr. LINDSETH. Senator, you have gone only part way. You have excluded alternate methods to that of the development of this nuclear economic power by the Government. For example, you have excluded the possibility and the opportunity which we feel is very real and very great to accomplish these objectives at lower cost to society, possibly sooner, by the development through the free-enterprise system.

Senator GORE. In that I will join you. I want to facilitate your efforts. I commend you on the effort that you have made. It is a risky, hazardous business into which you can venture at great risk to your stockholders. I congratulate you on what your industry has done. I welcome your efforts. I want to aid and assist and facilitate your further success. The greatest aid that the Congress, in my opinion, can possibly provide is the expeditious demonstration of economic atomic power. I solicit your assistance.

Senator PASTORE. Will the Senator yield?

Senator GORE. I yield.

Senator PASTORE. Do you feel that private industry alone in this country can meet the challenge of research and development in this field in competition with Russia where the economy is regimented, and England, where it is nationalized?

Mr. LINDSETH. With regard to answering the question in connection with Russia I have the extreme difficulty of wholly inadequate information on their program. With regard to England, the situation is different. I do believe that under the Atomic Energy Act of 1954 this country is making vastly greater progress than in England in the ultimate achievement of economic electric power.

Senator PASTORE. But we have heard only within the last few days that the Japanese, who receive much more foreign aid from America than they receive from Great Britain, are contemplating buying a gas-cooled reactor from England rather than buying one from the United States. Wouldn't that be a cause of concern for you if you were sitting on this side of the table?

Mr. LINDSETH. From the point of view of our international position in world affairs?

Senator PASTORE. From the point of view that apparently we have been outdistanced in one respect.

Mr. LINDSETH. We certainly are not outdistanced by the reactor which, conservation has it, that the Japanese are contemplating buying, which is a Calder Hall duplicate. We need make no apologies in America for not having the Calder Hall type. Everybody would agree with that.

Senator PASTORE. How do you explain, then, the decision of the Japanese to buy one as against buying one from us?

Mr. LINDSETH. I don't know what is uppermost in the minds of the Japanese.

Senator PASTORE. I realize you don't know that, but doesn't it cause you concern?

Mr. LINDSETH. From having talked to Sir Edwin Plowden about Calder Hall, it is a plutonium producer. It is necessary for the military program in England. It is justified as a plutonium producer. It generates electric power incidentally. It is not operated by the nationalized electric industry in Britain. It is located on an atomic-energy installation and operated by atomic-energy personnel.

When we get in to the interrelations of weapons and power our industry is excluded and properly from the weapons considerations. Any statements about economic power in Britain are necessarily qualified by the plutonium credits. I repeat that the reactor technologically is not nearly as advanced as in America. They do have a singleness of purpose. They have a desperate necessity for developing a reactor that will generate power at any cost by virtue of the growing shortage of coal, the inability to get dollars with which to buy oil, the very difficult political Near East situation and the restrictions on the normal supplies from the Near East.

If the Japanese, for whatever reasons, need a plutonium producer of the Calder Hall type, which is a plutonium producer and not a power reactor, then they may have been talking to the wrong people in America about buying a plutonium producer. I am in the realm of speculation there.

Senator PASTORE. I hope you are right. Unlike some of my colleagues, I quite agree with you that there is a fitting place in research and development for a partnership between government and free enterprise. That was the motive and that was the spirit of the 1954 amendment, and I heartily supported it and talked in favor of it

on the floor of the Senate. You have to realize, too, that with the establishment of in international agency for the peaceful uses of atomic energy, electric power produced by atomic energy has become a basic part or an integral part of our foreign relations or foreign policy, because it would serve us little purpose to offer the the world 20,000 kilograms of uranium, U–235, to burn in reactors if we are going to lose the reactor race to Russia or Great Britain. Wouldn't you agree with that?

Basically there is an interest here that far transcends the normal course of private industry or private-enterprise motives, for the reason that, after all, if you were left on your own there is no immediate need for electric power produced by atomic energy. We have an abundance of fossil fuels and conventional fuels in this country. But we are in a competition with the rest of the world. We are trying to win the hearts and the minds of people all over the world. We feel that one way of doing it is to reach this goal of producing a competitive basis electric power through atomic energy.

Why doesn't that create a necessity for Government participation in this field? Why should it be resisted by private industry if one does not step upon the toes of the others?

Mr. LINDSETH. Your question is in two parts.

Senator PASTORE. I think it is in three parts.

Mr. LINDSETH. Let me take the last part. First with regard to the desirability of our achieving economic electric power, I hope there could be no dissent in this room, in our industry, or anywhere in America that that is a desirable objective locally, nationally, and internationally.

Senator PASTORE. I admit that.

Mr. LINDSETH. That is a premise on which we can start. Then we get to method, in the manner in which we get to method in the discussion with Senator Gore, whether a program of greater magnitude than the present one by government is the best way to achieve a mutually agreed on worthwhile objective. We differ only in method. We don't differ in the objective at all.

Senator PASTORE. What is the method that you differ with? What is there in the Government program that is objectionable to you as a businessman, if it is confined alone to reaching the state of practicability and not getting into commercial use?

Mr. LINDSETH. We are now implying an alternate that hasn't been expressed in these hearings, namely, the alternate to the program now going on in the country which presumably is an acceleration by the Federal Government of a reactor program. I was asked by the chairman if we would withhold our comments on acceleration until subsequent hearings and devote ourselves at today's hearings to the state of the art in the country. I do not come prepared to discuss any proposed legislation.

Senator PASTORE. That being the case, I shall not press the point.

The CHAIRMAN. Senator Dworshak.

Senator DWORSHAK. In your statement, Mr. Lindseth, you mention that Pacific Gas & Electric Co. in California is planning some development of reactors, and in your listing of members of the Edison Electric Institute you have Utah Power & Light. With those two exceptions I do not find the names of any private utilities from the West or the Northwest. Is there any significance in that?

Mr. LINDSETH. First of all with regard to Pacific Gas & Electric, it is by its indication this week now to be participating in three reactor projects simultaneously, which is the greatest number being undertaken by any American company. Second, with regard to the membership in additional groups, I believe the statement by Pacific Gas & Electric said that they would do this alone or in conjunction with others, and presumably the arrangements have not proceeded to such a point that they can disclose their partners, assuming they are going to get some.

Other than that I have no comments on your question, is there any significance.

Senator DWORSHAK. Does your institute embrace the entire county, all the States——

Mr. LINDSETH. Excuse me one minute, if I could interrupt. Southern California Edison is a participant in one of these projects, a joint venture in which the AEC through North American Aviation plans to construct a sodium-graphite reactor at Santa Susanna for which Southern California Edison Co. has installed a generator.

Senator DWORSHAK. Do you know whether your institute does represent the private utilities of the West with those exceptions?

Mr. LINDSETH. Oh, yes, they are member companies in the Institute.

Senator DWORSHAK. Why don't you list them? What I am trying to develop is merely this. I am not contentious in any way. I am just wondering whether there is any apparent interest on the part of utilities in the West in this broad development or whether because of the vast potentiality of hydroelectric power, they are manifesting no interest at this time. Do you know?

Mr. LINDSETH. Yes, I do know, and it would be a misimpression to say they do not manifest any interest in this problem at this time. As you know, in California the vast bulk of our industry, 90 percent of the entire industry, is in 2 companies, Pacific Gas & Electric and Southern California Edison, both of which are working intensively. Pacific Gas is a member of 3 projects. Southern California is a member of the project I mentioned. Above that, in Oregon, Washington, Montana, I believe the Chairman of the Commission mentioned that he had received a letter from that group setting forth their studies, their interests, their problems. I don't have a copy of that letter but having read the record I was put on notice. Possibly it was put into the record so you might have access to it.

Senator DWORSHAK. Apparently there is greater interest in the Midwest and in the East because of the greater need of developing other sources of power. Is that true?

Mr. LINDSETH. I am not sure that I would state it that way. In the Pacific Northwest, by virtue of the preference clauses in the contracts, power presently available to our industry distributors will decline in the course of time, being reserved for preference customers, with the result that our industry will either exploit, to the extent available to them, hydro sources or it must turn to nuclear projects in the Pacific Northwest.

Senator DWORSHAK. The preference clause doesn't apply to exclusive private development. It is only when the Government is involved, Federal plants. Why would you mention preference clauses as being a deterrent of any kind in the development of this as far

as private utilities is concerned? Is it not true that private utilities can engage in any development, whether it be hydroelectric or this particular atomic energy development, and so long as they are investing their own money the preference clause does not apply.

Mr. LINDSETH. Yes, that is the case. I might have misspoken in the use of the term. Presently the industry portion of the Pacific Northwest is obtaining power from the Bonneville Power Administration, but because of the operation of the prefence clause that amount of power in the years to come will decline, being transferred to preference customers. As a consequence of that, I see an added incentive to those people for the construction of nuclear plants, absent hydro resources.

Senator PASTORE. If you expand.

Mr. LINDSETH. That is inevitable.

The CHAIRMAN. Mr. Lindseth, most of the group that you represent this morning—I don't know the exact number—will be participating under the third-round program of the AEC. Since under the third round, research and development costs can be absorbed by the Government, the committee has been concerned about the increased cost of these plants, it having gone, I believe, from $55 million to $70 million for Consolidated Edison of New York. What is your thinking there? Will private industry absorb this extra cost or will a large part of it revert back to the Government's cost under the present program?

Mr. LINDSETH. We are speaking now of a proposal under the third round?

The CHAIRMAN. That is correct. That is a good deal to be absorbed, much more than under the first and second rounds.

Mr. LINDSETH. Yes. I think the third round in that regard will make a further contribution to the hastening of the day when we will achieve economic nuclear power. I believe it is stated in the published reports that both of these very recent proposals, that of Pacific Gas & Electric and its partners, and the Ohio Valley group, will both be submitted under the third-round invitation to submit proposals and both contemplate at least the discussion with the Commission with regard to research and development costs.

The CHAIRMAN. Has the same thing happened throughout the country with the conventional type plants? Have their costs increased comparable to the increased costs of the type that we are building under these programs?

Mr. LINDSETH. Yes. The inflationary pressures are being brought to bear on the components that go into a powerplant, on steel, building construction, and all that.

The CHAIRMAN. It takes about 3 years to build an ordinary 400,000 kilowatt capacity conventional plant.

Mr. LINDSETH. Yes.

The CHAIRMAN. Over that 3-year period of time what would you estimate the increase in cost to be? Could you make a guess? I am trying to get in my mind whether or not this is happening just to this new industry or if it is happening to the entire industry.

Mr. LINDSETH. Taking the last part first; by no means are these inflations in cost limited to the nuclear power industry, because they are being felt, and we have noted with some concern the cancellation of industrial projects in America where the increased cost estimates

have made unattractive the building of new industrial plants of many types. With regard to a factor in the conventional plant, if the design were fixed as of 3 years ago we were relatively stable as to costs at, let us say, January 1, 1954. It was not really until mid-1956 that the consumers price index was rising, with the result that wage contracts geared to the consumer price index had automatic escalators. We negotiated nationally—not we, but America did—wage contracts carrying automatic productivity improvement increases over the years ahead, some for 3 years, some for 5 years. Those rising costs are now being reflected in rising prices, the increased prices of steel, construction labor, electrical machinery, and other factors.

A powerplant put on the line today which was started January 1, 1954, would probably not have cost very much more than a sound estimate of 3 years ago. But a powerplant designed today, priced at January 1, 1957, price levels, would undoubtedly prove to cost considerably more 3 years hence when it would go on the line, because of the inflationary cost factors ahead of us.

The CHAIRMAN. Would you hazard a guess as to the percentage? In this third round we have assumed a great deal more responsibility in the payment of the cost of this development. There is a much more liberal attitude.

Mr. LINDSETH. You say would I hazard a guess. I would. That over a 3-year span in the composite on the order of 15 to 25 percent.

The CHAIRMAN. How about your estimate? Would you take that into account now?

Mr. LINDSETH. In a budget appropriation in our company we clearly would.

The CHAIRMAN. You would?

Mr. LINDSETH. Yes, as we have in the past.

The CHAIRMAN. We can expect about the same, then, can we not?

Mr. LINDSETH. It depends on the basis on which the estimate would have been determined and whether it would adequately anticipate the inflationary price pressures of the future. Given sound assumptions, we should get sound answers for the factors that I have been speaking about, namely, unit increases in labor, material components and the like. Unanticipated technological difficulties of the type which have been experienced in the past year in some of the reactor experiments which have been delayed in time and have cost more. These have proved tougher than was expected at the time they were conceived.

The CHAIRMAN. Any further questions, Senator Gore?

Senator GORE. Mr. Lindseth, in the further hope that we might convince you, an influential member of the private power industry, that this committee has no injury to your industry in mind, I want to recall to you that this committee reported a bill last year, without opposition. If I may be a bit personal, the distinguished Senator to my left, Senator Pastore, for whom I have as high regard as any person, represents an area which is entirely served by private power. I represent an area which is almost entirely served by public power. Yet we could find a meeting ground that would not trespass upon the industry of his State or the interests of public utilities which I represent. The bill provided that the Government build some demonstration reactors on Government sites, and that the power be used entirely in Government facilities. This committee could not see how that would prejudice your interests or the interests of the public

utilities. We tried to avoid that fight. We thought it would be greatly in the interests of both private and public utilities and also in the interest of the United States of America, to have expeditious demonstration of economic atomic power.

I want to come for just a moment to the question of the Japanese prospective purchase of the British reactor to which Senator Pastore referred. I hope you will convey to members of your industry the concern which we who must represent the public interest, the national interest, on this side of the table, share.

You referred to the fact that the Calder Hall plant likewise produced plutonium. I spent a week in Japan and I worked on this question, trying to learn, trying to develop all the facts I could on it. I was favored with conferences with people in authority all the way up to the Prime Minister. Not once was the subject of plutonium production mentioned.

I wish to point out to you that, whereas the first Calder Hall plant is dual purpose, the second phase is something else. I don't want to delay you but I would like to read just a paragraph from a statement given to this committee by the Atomic Energy Commission itself on May 22 last year.

The second phase in the British nuclear power program consists of the construction by the CEA of three stations beginning in March 1957 with completion in late 1960 or early 1961. These are complete redesigns of the Calder Hall type of reactor. The most recent estimates indicate that these powerplants may be capable of 300 EMW/pair—

I am not sure of the meaning of that.

Mr. LINDSETH. Electrical megawatts; 300,000 electrical kilowatts.

Senator GORE. Thank you.

at a cost of $300 KW (not including U inventory).

I am not sure what all these terms mean. Continuing to read:

These reactors will reemphasize the production of power as contrasted with the production of Pu in the Calder Hall reactors. It is estimated that the power will cost 7 mills/kilowatt-hours after plutonium credit (2/3 mill/kilowatt-hour), which is competitive with power from existing conventional plants, based on the British accounting system. In the United States the equivalent cost would be 10 to 11 mills/kilowatt-hour.

That ends the paragraph.

As I talked to the officials over there I undertook to dissuade them from doing this. I turned devil's advocate, if I may say so, and pleaded Mr. Strauss' program. I pleaded with them that if they would wait until our research and development program had its full sway, I felt confident that we would be able to develop a more efficient reactor. But, they said, we cannot wait 5 years. They need atomic power now, and they are going at least to consider the purchase of a reactor from a country that has one in operation, which is producing what to them is economic power. You know the old adage in the mercantile business, you can't sell something that you don't have in stock. We just haven't got one in stock.

This gas-cooled reactor offers great promise. We think it should be developed in this country. Under the present law the Government cannot build one. It can only await the initiation and the proposition by some private concern and then react negatively or affirmatively. We just do not feel that that kind of program is adequate to maintain American leadership in the vital field of nuclear power. If your

industry would join with us in bringing about a demonstration program, I say with all the sincerity of my being that it would prove a great boon to the industry that you represent and a great boon to the country of which you are a responsible citizen and for which we have the responsibility of serving. I thank you.

The CHAIRMAN. Thank you very much, Mr. Lindseth.

Senator GORE. I didn't charge anything for that, Mr. Lindseth.

Mr. LINDSETH. Thank you very much.

Senator GORE. I wish you would give my personal regards to Mr. Dixon.

The CHAIRMAN. The next witness is Mr. Gordon A. Weller, executive vice president of the Uranium Institute of America. We will talk now about the fuel instead of the end product.

STATEMENT OF GORDON A. WELLER, EXECUTIVE VICE PRESIDENT, URANIUM INSTITUTE OF AMERICA, GRAND JUNCTION, COLO.

Mr. WELLER. Mr. Chairman and members of the Joint Committee: The opportunity of appearing here to discuss some of the developmental problems relating to the production and processing of uranium is appreciated. My name is Gordon Weller, and I represent the Uranium Institute of America, of which I am executive vice president. Our headquarters are in Grand Junction, Colo.

Since this is the first occasion for a representative of our institute, or of the uranium-producing industry, to appear at these 202 hearings, I trust that you will allow me a word of introduction.

Our trade organization was established approximately a year ago in the recognition that uranium was a unique commodity of spiraling importance in our national and world societies. Because of the dynamic nature of uranium, it was deemed wise to provide an instrument by which firms in the industry could devote specific consideration to all aspects of the exploration, production, processing, and marketing of this new important source of energy.

The uranium institute is enjoying rapid acceptance throughout the industry. Although we are yet to celebrate our first anniversary, we estimate that our organization today represents approximately one-third of the tonnage of current uranium ore production and processing, and better than one-half of the known reserves.

As you know, uranium ore production and processing, with isolated exceptions, is in the hands of private industry, working under contractual relationships with the United States Atomic Energy Commission and its designees. Circular 5, made effective March 1, 1951, serves as a basis for the purchase of ore from mining operations, and milling contracts are individually negotiated by the AEC on the basis of the specific operating conditions.

With the advancement of ore processing technology and the consequent improved efficiencies, processing costs are approximately one-third less than their level of 4 or 5 years ago.

This remarkable improvement in the cost of producing concentrates is, we believe, a great tribute to the working relationship of the Commission and industry in the areas of metallurgical and chemical research. There undoubtedly is opportunity for further processing cost improvements in this field.

Mining costs are also being driven down, but this situation is not yet well defined for two reasons: (1) Some mine operations are not able to produce at their most economic level because of restrictive quotas made necessary by limited milling facilities; and (2) several new areas just now being opened, such as Ambrosia Lake in New Mexico, are too recent in their state of development to afford a well defined production cost yardstick.

Significant advancement has been made with regard to uranium ore reserves as we are all aware. Sixty to sixty-five million tons of ore of an average grade approximately twice that of the reported reserves of Canada now await domestic production. This progress is again most encouraging, but it is important to note here that ore discoveries have far exceeded the related level of ore processing capacity and, as a result, some small operators are experiencing difficulty in marketing their ore in sufficient quantity to meet current operating expenses. This is particularly true in newly developed areas.

Senator GORE. May I ask a question, Mr. Chairman.

The CHAIRMAN. Senator Gore?

Senator GORE. That is a problem, Mr. Weller, which to my knowledge has not come before this committee before. I thought there was a ready market for all uranium ore. Yet you say that certain small producers are experiencing difficulty because——

Mr. WELLER. Because of the absence of milling facilities.

Senator GORE. In other words, the original raw ore gatherer or producer is having to hold his ore in stock because of inadequate processing facilities.

Mr. WELLER. Yes, sir. He has undergone quite a bit of developmental expense in proving out an ore body and judging the capital costs for exploitation. At that point he is unable to go into production because of the lack of milling facilities and only a limited buying program by the AEC.

The CHAIRMAN. All of these processing plants, except one, are owned by private enterprise, I believe.

Mr. WELLER. Yes, sir.

The CHAIRMAN. That was the one we built originally.

Mr. WELLER. That is right.

The CHAIRMAN. Private enterprise took the job of building these processing plants, and they have not built them fast enough to meet the demand? Is that true?

Mr. WELLER. Yes. This is a condition which, I think, is transitory. I am simply making the observation because I feel you need a report on the existing conditions of the industry. I think it may be broadened upon as we continue our statement.

Development incentives such as DMEA loans for ore exploration, discovery bonuses, and buying programs through temporary buying stations have done much to relieve this condition, but the only adequate solution appears to be the completion of an adequately drawn program for ore-processing plants.

I changed that word from "presently" drawn to "adequately" drawn program, because there are still process plants under consideration and they are being developed for contract by the Commission.

From 2 to 3 years are required between the beginning of negotiations for a mill contract, and the final start up of the completed mill. It

is accordingly urged that the Commission continue its careful periodic review of the ore-buying station program in order to assist the small producer bridge the gap during the period of development of new areas.

I might indicate here, further to answer your question, Senator Gore, the Commission has had an objection, after it feels that it has reached the requirement of our military necessity for adequate supply of uranium, to stockpile ore above ground because of wind erosion and other depreciating factors on uranium.

It might be that they have to transport the ore to a buying station which would not be conveniently located with respect to the ultimate mill. Therefore, here has been a program of reducing this buying program.

We simply urge here that, while we see the requirements of the Commission to do this, that it not be executed to the point of rendering serious harm to the small operators.

The CHAIRMAN. Do you mean to say that at the present time some individual who is digging ore out of the ground cannot dispose of it?

Mr. WELLER. Yes; there are those individuals.

The CHAIRMAN. It has been my understanding that we have been in position to buy all of this as it comes. Is there a lack of facilities to get it to some distant point, or what?

Mr. WELLER. It is the revised policy of the Raw Materials Division.

The CHAIRMAN. Is this isolated rather than the general rule?

Mr. WELLER. It is the rule in two particular areas, Cameron, Ariz., and Gas Hills region in Wyoming. In both of these regions there are milling facilities in the planning or construction stage. I think that the condition will be relieved within 12 to 18 months.

The CHAIRMAN. There have not been any processing plants closed down?

Mr. WELLER. No, sir.

The CHAIRMAN. That is what I thought.

Senator PASTORE. You did say, did you not, that as soon as we reach an adequate supply of what the Government needs for military uses, then it is inclined not to leave this ore above ground. You did say that, did you not?

Mr. WELLER. Yes, sir. I am, of course, not prepared to know what our military requirements are.

Senator PASTORE. Let us not leave that as a factor of speculation because it is quite serious. How would you know or how would anybody know what our military needs are?

Mr. WELLER. I think we find statements of the Commission officials who made a general statement that as military requirements are being satisfied, it is no longer necessary to extend buying stations.

Senator PASTORE. That has been stated as a policy?

Mr. WELLER. Yes, sir.

Senator PASTORE. I wish you would get it in the record.

Mr. WELLER. I am not sure that I could refer to it at this hearing.

Senator PASTORE. With the permission of the chairman, I think we ought to leave the record open at this point for you to make that insertion because I think that is quite important. Furthermore, I think we ought to investigate that if that is the case.

The CHAIRMAN. Will you put that statement in the record?

Mr. WELLER. Certainly. I will be very happy to.

(The statement referred to follows:)

[Extract from remarks prepared by Mr. Jesse C. Johnson, director, Division of Raw Materials, U. S. Atomic Energy Commission, for presentation at the National Western Mining Conference, Denver, Colo., February 9, 1957]

(First paragraph of the official AEC release, p. 1)

We now have reached the position where the uranium supply from existing contracts and from estimated increased domestic production will provide for the Commission's requirements as now established. We no longer are concerned over the possibility of a uranium shortage for the Government's military and power development programs as projected for the next 10 years.

(Second and third paragraphs, official AEC release, p. 7)

AEC construction and operation of ore-buying stations in new areas pending the development of sufficient ore to support an economic milling operation were undertaken to speed production for defense. Ore-buying stations are costly to build and operate. Stockpiles of ore are subject to wind and erosion losses and tie up large amounts of capital. If sufficient ore is not developed to support a mill, there is the additional expense of shipping the stockpile to a mill in another area.

The operation of ore-buying stations and the accumulation of ore stockpiles in excess of current mill requirements no longer can be justified on the basis of a military emergency. Furthermore, only in periods of emergency, when concentrate production is needed in a hurry, is there justification for expensive milling facilities to handle the short-term capabilities of the ore producers.

(The entire statement of Mr. Jesse Johnson appears in pt. 2, p. 709.)

Mr. WELLER. The growing uranium industry has imposed many municipal problems in various communities adjacent to mining and milling operations. Some small towns have experienced severe population increases which have created housing and school emergencies, and other emergencies. Typical of these communities are the cities of Grants, N. Mex.; Moab, Utah; Grand Junction, Colo.; and Riverton, Wyo.

The CHAIRMAN. You are not included under the impacted area provision whereby you can get supplements from the Federal Government for schools?

Mr. WELLER. I am not fully familiar with the problem. I know that the community of Moab, Utah, has received perhaps $150,000 from the Federal Government in its emergency program. I believe this is being done. It is a matter of an emergency loan, I believe, and still is reflected upon the communities' indebtedness.

I include with this report a summary of information dealing with the details in increases in population, bonded indebtedness, and business expansion that has been experienced in these communities. These communities are doing a commendable job of meeting their problems, but it should be emphasized here that uranium industry stability is essential to the ultimate solution of such problems.

In other words, the indebtedness which they are incurring is contingent upon the health of the industry.

On May 24, 1956, the Atomic Energy Commission announced the extension of its ore-buying program beyond March 31, 1962, on the basis of a guaranteed price of $8 per pound of U_3O_8 contained in concentrates. This extended buying program, which terminates December 31, 1966, eliminates haulage allowances, production bonuses, and other incentives which the industry is enjoying at the present time, and places the producer in the position of negotiator with mill operators for the sale of his ore.

Our institute acknowledges that it is an important step in the desired course to a commercial market, and we plan to carefully study the expected effects of this program as the economics at the time of change become more clearly defined. We face this transition with confidence, however, feeling certain that inequities that do become apparent can be worked out. On June 25, 1956, Mr. Jesse C. Johnson told the uranium industry:

> As I have indicated, the guaranteed $8 price was based upon a study of conditions today. We have no crystal ball to tell what the economic conditions will be in 1962 or 1966. Neither can we predict the size and grade of the ore reserves that will be available for mining in the period 1962 through 1966.
>
> If the price is too low to bring out the required production, it can be raised, or special premiums established for marginal production.

As we indicated at the beginning of this statement, we see the opportunity for further economies in ore processing and perhaps in mining. We hope that such developments will prove the $8 figure to be realistic.

The buying extension program also carried the provision that the Commission reserved the right to limits its purchases of concentrates derived from any 1 mining operation or property to 500 tons of U_3O_8 per year. The precise meaning of "mining operation or property" is yet to be clearly defined, and the institute looks hopefully to the time when this will be clarified.

There is still another matter of concern to a large segment of the uranium-mining industry. Whereas the indicated uranium-ore reserves are considered to be large at the present time, they are large only in relation to the present demand. Furthermore, a large part of this reserve tonnage is concentrated in confined deposits that will in degree be limited as to the size of the exploitation, in any given year.

It should be indicated here that there are other areas that are limited with respect to reserves for the milling capacity established at the present time.

For this reason, it appears quite likely that some of the existing mills will experience difficulty in obtaining sufficient ores by 1965. The mining fraternity recognizes the tremendous amount of geologic information which has been accumulated during the past several years by the Federal agencies, particularly the Atomic Energy Commission and the United States Geological Survey.

It is further recognized that these agencies are experiencing technical staff depletions through resignations and abolishment of positions. With the dispersal of geological personnel from these agencies, the opporunity for a careful coordination of information will be largely lost.

The institute, therefore, recommends that present programs be intensified for assembling these data into a workable source of reference so that it will be preserved and available to the industry 7 to 10 years from now when we predict exploration will be greatly intensified. The dispersal of such technical staffs prior to the completion of this work will result in irreparable loss.

FUTURE PROGRAMS

In an address before the National Western Mining Conference 2 weeks ago, Mr. Jesse Johnson stated in his opening remarks that "* * * it is my opinion that the uranium industry should now study

the potential commercial market and look to that market for its support after 1966." Mr. Johnson again urged the industry to develop its own basis of planning and survey in contemplation of this market—a recommendation which he also made before the Joint Committee at this hearing 1 year ago. The Uranium Institute subscribes to Mr. Johnson's recommendations, and we should like to use this occasion to explore the course that the industry must follow in reaching our future commercial market.

First, again we need a definition—the meaning of "commercial market" as it is used here. Is this a market related to concentrates alone, or will the subsequent steps leading to the production of fuel elements also assume their natural price levels in accordance with the commercial market concept?

While it is desired that industry orient its thinking to the future commercial market, the industry knows little as to the various forces which will be of direct influence to it. I am referring here to the uranium-producing industry.

We understand that 140 pounds of depleted uranium is being produced and stockpiled for every pound of U^{235}. Through the use of breeder reactors, this quantity of depleted uranium can be converted to productive fuel. What are the economics of this process compared to the production of natural uranium? What influence will it be to the future mining and milling industry?

There again appears to be increased interest in thorium. Will the homogeneous thorium reactor prove of great appeal than reactors totally fueled by uranium?

The business of uranium-ore production and processing is fast growing to be a $300 million business in the West. Its operations have been based upon price schedules and mill contracts which have been clearly defined. Incentives have brought further assurances.

I believe that the industry is willing and ready to follow a course of well-planned transition to a commercial market, but such a transition is impossible without adequate answers to these and related questions.

The Uranium Institute is currently planning a flying tour of the eastern United States and Canada in order that representatives of the industry can develop a better understanding of the uranium market as it exists today. Reactor research facilities will be visited at Argonne National Laboratory and at the Oak Ridge National Laboratory, and production facilities at Blind River, Canada, will be toured.

Tentative plans, however, for the visit of feed material plants that receive concentrates from the West are being waylaid because of our inability to satisfy the Atomic Energy Commission authorities of the justified interest in the feed materials program by such production groups from the West.

We submit that as the first step of the producing industry's approach to a commercial market, opportunities leading to a better understanding of the economics of producing uranium and of its application in the power and isotope market must be made available to the industry.

We acknowledge that vast areas of information have been declassified during the past 12 months, but we submit that the process is far from complete and that further measures in declassification must be taken at an early time to avail the industry of the information it requires. The successful transition of the uranium industry to a commercial market is contingent upon these measures.

Atomic industry evaluation: The atomic energy business is of such a dynamic nature that long-term forecasts must be closely related to the progress of basic research. Such basic research not only stands as the greatest ally in our advancement to a commercial market, but also as the greatest threat to premature obsolescence of capital facilities. This relates not only to the reactor program, but to the other processing programs as well because basic research continues in this area. Since the Nation's atomic energy program is not confined to uranium alone, the results of this basic research are all the more important to the uranium industry, because of the competitive factors.

It is expected that even with such knowledge, long-term projections on the demand for uranium will be exceedingly difficult and that a continuing study will be required for the guidance of the industry. For this reason, it is proposed that an atomic industry evaluation committee be established composed of representatives of Government and industry.

The purpose of this committee would be to correlate rsearch, operation, fuel production, plant cost and market data, and, on the basis of these data, to estimate the cost and magnitude of the future nuclear power program, and the related requirement for raw materials.

Information of this nature will be most important in the planning of exploration programs, ore production schedules, plant expansions and their related capital requirements, and personnel training plans. The same benefits will be derived by the utility and power equipment industries in the programing of their operations.

Forecasts should be made anually for 5-, 10-, and 20-year periods. A longer period forecast should be properly qualified with respect to the many variables involved in such projections.

The function of the Atomic Industry Evaluation Committee should be evaluative rather than regulative. Existing regulating bodies are sufficiently adequate for the protracted requirements of this new development.

Because of the present character of the atomic energy industry with broad areas of research and industrial activity under the direct supervision of the Atomic Energy Commission, we feel that the details of the atomic industry evaluation must be developed in close coordination with and most likely at the incentive of the Commission.

We anticipate widespread support for such a program will be immediately forthcoming from the uranium producing and processing industry.

In presenting these observations to you gentlemen of the Joint Committee, we wish to emphasize that the institute is dedicated to a philosophy that is strictly opposed to protectionism. We are extremely confident of the future of atomic energy as an industry, and of uranium's place in the future.

We cannot be nurtured on price schedules and market guarantees, but rather through complete understanding and careful planning. The statement that we have made here is presented with that thought in mind.

I thank you.

The CHAIRMAN. Thank you very much, Mr. Weller.

Mr. Weller, since this is more or less a unique mineral and it has been treated so because the mining operation is entirely different, I

have been thinking for quite some time that we face a situation where it is necessary to have a permanent, long-range policy laid down by the Government.

I have been thinking of something along the line of the Strategic Stockpiling Act, the policy on strategic and critical metals since 1946. A few days ago I introduced a measure which was an amendment to the act with that in mind.

Have you given any thought yet as to how it would work with your industry?

Mr. WELLER. I am not acquainted with the measure which you have proposed, Mr. Chairman. I would like to know the number of it.

The CHAIRMAN. I will submit a copy to you and you can study it. I would like to have the comments of the mining group on it.

Mr. WELLER. We would very much like to do that, sir.

The CHAIRMAN. I definitely think we will have to lay down some kind of long-range policy.

Mr. WELLER. We strongly feel the same way.

The CHAIRMAN. It is a very strategic and critical mineral in my opinion and should be so classified. The group goes up and down, but I believe some 70 minerals are included in the group now.

(H. R. 5010 referred to follows:)

[H. R. 5010, 85th Cong., 1st sess.]

A BILL To amend section 161 of the Atomic Energy Act of 1954

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That section 161 of the Atomic Energy Act of 1954, as amended, is amended by adding thereto a new subsection reading as follows:

"s. The Commission is authorized to exercise, with respect to any source materials, the powers conferred on the Army and Navy Munitions Board, the Administrator of General Services and the Secretaries of the Interior, Agriculture, and Commerce under the Strategic and Critical Materials Stock Piling Act. It shall report on its activities under this subsection to the Congress in its semiannual report."

The CHAIRMAN. You can store uranium for an indefinite period of time. I do not think there is any storage problem involved here as to deterioration. It has a long life, as you know.

Mr. WELLER. Yes, sir. This is a statement which has been made by the Raw Materials Division and I will be glad to enter it in the record.

The CHAIRMAN. It is a matter to take up with Mr. Johnson because he is a well informed mining man.

Mr. WELLER. He certainly is. The industry has great respect for Mr. Johnson.

The CHAIRMAN. I want to say at this time that in my opinion, the development of this industry has been one of the best programs carried on by the AEC. We had nothing to start out with.

The boys in the West went out and did a good job in support of the AEC. I hope your interest will continue.

Are there any questions?

Thank you very much, Mr. Weller.

The CHAIRMAN. Mr. Grahl?

Mr. Grahl is appearing for Mr. Samuel B. Morris who, we understand, is unable to be present.

STATEMENT OF SAMUEL B. MORRIS, CHAIRMAN, ATOMIC ENERGY COMMITTEE, AMERICAN PUBLIC POWER ASSOCIATION (PRESENTED BY JAMES L. GRAHL, ASSISTANT GENERAL MANAGER)

Mr. GRAHL. My name is James L. Grahl. I am the assistant general manager and director of the atomic energy service of the American Public Power Association. Mr. Morris called last night and wishes to apologize to you for being unable to come. He had a last-minute change. We are sorry he could not be here this morning.

The CHAIRMAN. Proceed, Mr. Grahl. If Mr. Morris cares to, he may appear at a later date.

Mr. GRAHL. The American Public Power Association, representing more than 800 local publicly owned electricity utility systems, has had a longstanding interest in nuclear power development, most recently illustrated by its comprehensive recommendations on Federal atomic power policy. And copies of these were furnished to the committee with Mr. Morris' statement.

The association believes that national policies should encourage the development of a competitive nuclear power industry and minimize tendencies toward monopolistic patterns.

We therefore are deeply concerned about AEC's third invitation for proposals because its terms have the effect of freezing out the local publicly and cooperatively owned utilities and, at the same time, stimulating the formation of additional large private utility combinations to sponsor nuclear power projects. This new policy also may restrict opportunities for expanded activity in the power reactor manufacturing field to the very large and wealthy industrial firms.

The association recommends careful review of the terms of AEC's third invitation by this committee, AEC and the Department of Justice to determine whether, in the interests of avoiding monopolistic tendencies and strengthening competition, the invitation should be withdrawn or drastically modified.

For similar reasons and in light of recent remarks by the Attorney General, we recommend consideration by this committee of the need for amending the Atomic Energy Act of 1954 to strengthen the antimonopoly provisions applying to research and development licenses for atomic energy facilities.

AEC's demonstration program does not seem to be getting nuclear power projects built very rapidly and does appear to be stimulating the formation of utility and industrial combinations which may cause monopoly and antitrust problems in the future. Experience to date strengthens our conviction that this program must be supplemented by Federal projects as proposed by Senate bill 151 and House bill 2154 (the Gore-Holifield bill) if the United States desires to demonstrate international leadership in the development of economic nuclear power. Such projects would, in our opinion, advance the technology to the point where normal business incentives can become effective.

(The full statement of Mr. Morris is as follows:)

My name is Samuel B. Morris. I am appearing here in behalf of the American Public Power Association as chairman of the atomic energy committee of that organization. The American Public Power Association is a nonprofit association representing over 800 local publicly owned electric utility systems in 40 States, Alaska and Puerto Rico. The headquarters of the organization is 1025 Connecticut Avenue, NW., Washington 6, D. C.

My position is consultant to the Department of Water and Power of the city of Los Anegles, Calif. I was formerly general manager and chief engineer of the department. Before taking the Los Angeles position in 1944, I was dean of engineering at Stanford University.

I have served for a number of years as a member of scientific panels or committees advisory to the U. S. Department of Defense. I have also served as a member of the President's Water Resources Policy Commission appointed in December 1950, and have been a member of the national water policy panel of the Engineers Joint Council. As you know, I was a member of the panel on the impact of the peaceful uses of atomic energy (McKinney panel) which was set up by this committee.

Our association has had a long-standing interest in the program for developing economically competitive nuclear powerplants and in the national policies affecting the nuclear power industry, as the following examples of our activities illustrate. In 1953, the association established an atomic power policy committee to make a continuing study of policy developments in this field. This committee has been very active and has submitted policy recommendations to the Atomic Energy Commission and developed testimony for presentation to your committee on numerous occasions.

In November 1956, the committee completed a comprehensive set of recommendations on Federal atomic power policy and these recommendations were adopted by the association's board of directors. We believe this to be the most comprehensive policy statement on atomic power issued to date by a national organization. A copy of the statement is attached to my testimony and I would appreciate its being made a part of the record, at the conclusion of my testimony.

In 1955 in response to the first invitation under the Atomic Energy Commission's power demonstration reactor program, the Consumers Public Power District of Nebraska, a member of our association, submitted a proposal to AEC to build a 75,000 kilowatt nuclear powerplant of advanced design. This proposal is still under negotiation with AEC.

During 1955, the association established an atomic energy service to keep our member systems currently informed of major policy and technical developments in the atomic energy field of particular interest to the local consumer-owned utilities.

In 1956, two more members of our association—the municipal electric systems of Piqua, Ohio, and Holyoke, Mass.—submitted proposals to AEC to construct atomic powerplants of 12,500 and 15,000 kilowatts, respectively, in response to the AEC's second invitation under the demonstration program. Both of these proposals were for plants of advanced design. The Piqua proposal is under negotiation with AEC. Unfortunately, after considering the joint Holyoke-Ford Instrument Co. proposal for 11 months, AEC concluded that it was technically "premature" and rejected the proposal.

The Piqua proposal was submitted to AEC in February, 1956, and contract negotiations have been underway since September. The original proposal of Consumers Public Power District was submitted in April 1955 and contract negotiations have been going on since October 1955. We hope that agreements can be reached soon on firm contracts.

The member systems of our association hope to participate still more effectively in the future in the development of atomic energy resources and in the establishment of policies designed to serve the best interests of the people of the United States.

The association's recommended Federal atomic power policy makes it clear that we support the objective expressed in Chairman Durham's letter inviting our testimony; namely, "to encourage maximum private participation in the peacetime atomic energy program." We believe strongly that it is necessary to adopt and maintain policies which keep the door open to active participation by industries, large and small, in the component manufacturing and reactor services fields, thus fostering effective competition.

For the same reason, we advocate assuring a continuation of the institutional competition between the privately owned electric utilities and the publicly and cooperatively owned utilities. Historically, this competition has had highly beneficial effects on the cost of electric power and quality of service. It therefore should continue to be fostered in this otherwise monopolistic industry. The maximum progress in the development and utilization of nuclear power will not be achieved, and the best interests of the power consumers and the general public will not be served if one segment of the utility industry comes to dominate the development and use of nuclear power.

The Government's role in the emerging nuclear industry is unusually extensive and important. The various policies it adopts will be decisive in determining whether the industry develops as an open industry, with strong competitive characteristics in both the manufacturing and the utility fields, or whether it becomes an industry in which competition in equipment manufacturing is limited to that among a few large corporations and the rates and availability of nuclear power are largely determined by a few giant aggregations of privately owned utilities.

AEC'S THIRD INVITATION FOR PROPOSALS

For this reason, we are deeply concerned about the terms of the Atomic Energy Commission's third invitation for proposals under its power demonstration reactor program. In our opinion, the terms of this invitation not only fail to encourage participation by all segments of the utility industry but actually encourage participation by large private utility combinations exclusively. This may not be the intent of the third invitation but this is its effect.

The local publicly and cooperatively owned utility systems will be unable to make proposals to the Commission under the third invitation principally because it precludes any financial assistance by the AEC on the construction cost of a developmental nuclear powerplant. By this provision, the member systems of this association are effectively frozen out of the nuclear-power program for the indefinite future, except for the two projects proposed under previous invitations and still under negotiation with the Commission.

In a letter to AEC Chairman Strauss of December 20, the general manager of our association, Mr. Alex Radin, explained that if the forthcoming third invitation "were to exclude any AEC financial participation in reactor construction financing, it would be very difficult for members of this association to make proposals to the Commission * * *"

The Commission nevertheless specifically ruled out any assistance with construction costs when it subsequently issued its third invitation. In his reply of January 31, 1957, Chairman Strauss said that the Commission believes the assistance offered on preconstruction and operating costs might be sufficient to elicit substantial responses from consumer and privately owned utilities, and referred to the possibility of participation in proposals by industrial firms.

Unfortunately, Mr. Strauss' comments are not particularly helpful in respect to the problem faced by our members. I respectfully request that both of these letters be entered in the record at the conclusion of my testimony.

Although I would like to share Mr. Strauss' implied optimism as to the possibility of obtaining reasonably firm contracts for the construction of nuclear powerplants at a bearable cost, our members have found this to be extremely difficult because of the state of the technology. In order to quote anything approaching an acceptable price on a nuclear powerplant, a manufacturer must accept considerable uncertainties as to what the actual cost and performance of the plant will be. Few are willing and able to accept these risks. We have made inquiries and we would be glad to learn of manufacturers willing to contract on this basis, at a price that a local publicly owned system could afford.

Commission staff also have suggested that the local publicly owned systems consider the sponsorship of projects on a group basis, in order to spread the abnormal costs and risks of a demonstration nuclear power project. Even if such an arrangement were desirable, it is in most instances a legal impossibility. Ordinarily, a municipally owned system cannot invest in facilities located in and serving some other city.

The Commission's policies apparently are also freezing out the individual privately owned utility systems. According to a survey made by Electrical World magazine and reported in its January 21, 1957, issue, privately owned electric utilities in several sections of the country are "actively making plans for cooperative construction of nuclear powerplants in the near future * * * 3 or 4 new groups varying in size from 4 to 20 members, have been formed specifically for this purpose." The report stated that "all of the utilities interested in building additional reactors are making plans on a group basis. No one company has made a commitment or is seriously considering building a reactor plant as an individual."

This report indicates a further extension of a pattern already established for privately owned utility projects. The Yankee Atomic Electric plant is being financed by a group of 12 utility systems; the Commonwealth Edison project by 7; and the Power Reactor Development Co. plant by 18. Projects also have been

proposed by a group of 3 utility systems in Florida, and by 4 systems in Virginia and the Carolinas. A project recently announced by Northern States Power Co. will be financed by 10 or more privately owned facilities.

Only one project scheduled to go ahead soon is financed by a single utility and it is the largest privately owned system in the Nation. It seems significant that the only nuclear-power projects under construction in which a single private utility is involved are projects in which the reactor system is being financed and the risk of cost overruns is being borne either by the Government or by the industrial firm building the reactor.

Thus it seems clear that the net effect of present Government policies coupled with the economics of nuclear-power development is virtually to exclude from the field all but large aggregations of privately owned utility systems. By offering substantial financial aid on terms which make proposals feasible only for such combinations, the AEC program is in fact actively stimulating their formation. It should be noted that this is, in the Commission's words, "a continuing program of assistance under which the Government will be providing subsidies to such utility combinations until June 1967."

Having enacted the Public Utilities Holding Company Act more than 20 years ago to remedy the ill effects of large utility combinations, it is a serious question whether the Federal Government should now be encouraging the formation of new combinations.

There is a danger that Government policies may have a similar effect in the equipment manufacturing industry. Since the sponsor of a proposal must, under the terms of the third invitation, bear the entire construction cost of the nuclear powerplant, a sponsor necessarily will employ the reactor manufacturer who is willing to contribute most heavily to the project, by bidding at or below cost and accepting the risk of cost overruns. In this situation, the very large and wealthy manufacturing corporations obviously are in a much stronger position to get the contracts than the smaller firms. Representatives of several companies with considerable resources have told us frankly that they do not see how they can participate, despite their eagerness to enter the power-reactor field or expand their work in it and despite their having well-qualified technical staffs.

Providing for free and equitable access to the nuclear-power field is admittedly a difficult problem but it seems to us doubtful that AEC's third invitation represents a wise approach. We recommend a careful review of the terms of the third invitation by this committee, the Atomic Energy Commission, and the Department of Justice to determine whether in the interests of strengthening competition and free enterprise, the invitation should be withdrawn or modified drastically.

ANTIMONOPOLY PROVISIONS

Attorney General Brownell, in a speech on January 24, 1957, took note of these combinations being formed to finance and operate nuclear-power reactors. With reference to the danger of monopolistic practices developing in the manufacturing field, he said that "although the companies seeking such licenses jointly may not presently be engaged in the same industries, such activities require considerable careful study, from a competitive point of view, both as to present actions in the experimental stages and in future activities when the commercial stage is reached." As a matter of fact, at least one such combination does include firms engaged in the same industries.

Mr. Brownell also observed that "in the case of the public utilities, I might add, such licenses for joint activities also raise the possibilities of questions under the Public Utilities Holding Company Act."

Mr. Brownell pointed out that the Department of Justice has a unique and important role to play in fostering competition in this new industry, saying that "we here have an opportunity to utilize preventive rather than remedial action." For this preventive role, Mr. Brownell expects to rely in part on section 105 (c) of the Atomic Energy Act which requires the Attorney General to advise the Atomic Energy Commission whenever, in his opinion, it is proposing to issue a commercial license which would tend to create or maintain a condition inconsistent with the antitrust laws.

However, section 105 (c) applies only to commercial licenses and not to the research and development licenses under which utility and industrial combinations are now being formed. Since the latter apparently will be the only type of license issued by AEC in the nuclear-power field for some years, Mr. Brownell is depending upon a legal provision which is not applicable to the

nuclear-power industry during this developmental period. Yet this is the time for preventive action, as Mr. Brownell recognizes, rather than some later period when AEC begins to issue commercial licenses and when the patterns of industrial and utility organization may be established.

We recommend serious consideration by this committee of the need for amending the Atomic Energy Act to strengthen the antimonopoly provisions applying to research and development licenses so that the Department of Justice can effectively take the preventive action which the Attorney General so rightly recognizes as highy important to the strengthening of free enterprise in the atomic energy field.

AEC PRICING POLICY

In respect to Commission prices for nuclear fuel materials, we commend the Commission for its recent action in declassifying its price schedules and urge that, to the extent military security permits, the Commission now make public the criteria used in establishing these prices. Until this is done, it is difficult to comment on the Commission's pricing policy.

Before closing, I should like to assure this committee that our lack of detailed comment on the six specific topics suggested by the committee for discussion at these hearings implies no lack of interest in these important matters. Although we are very much interested in these subjects, we have no comments which would add substantially to the committee's present knowledge of them.

PROJECT COST INCREASES

In respect to another topic mentioned by the committee—whether cost increases have occurred in civilian atomic-power projects—we have no direct knowledge but understand that increases in estimated costs for one or more proposed projects are occurring. These cost increases give rise to the question of whether the affected project will nevertheless go ahead on schedule and raise serious questions as to the actual status of the atomic-power-development program in this country.

Apparently substantial cost increases have occurred in respect to several Federal projects, including the PWR at Shippingport, the sodium-reactor experiment at Santa Susana, Calif., and the recently completed EBWR. Information on cost increases on several projects was presented in testimony before your committee by Commissioner Thomas Murray.

That similar increases in the cost estimates of privately sponsored projects may be occurring is suggested by the fact that the Commission's third invitation offers financial assistance retroactively to projects already proposed, where such additional aid would "materially accelerate the project." Considered in conjunction with the fact that in 2 years since the demonstration program was launched there have been 10 proposals but only 1 signed contract, this retroactive offer of aid raises the question of whether the demonstration program as presently constituted is proving to be as practical as AEC originally hoped.

Whatever its virtues, the demonstration program does not seem to be getting projects built very rapidly and it does appear to be stimulating the formation of utility and industrial combinations which may cause monopoly and antitrust problems in the future. We believe that the proposed privately sponsored projects should go ahead. But the experience of the past 2 years strengthens our conviction that the United States cannot rely entirely upon these if it desires to demonstrate international leadership in the development of economic nuclear power.

It seems increasingly clear that to get some full-scale prototype nuclear powerplants built expeditiously it will be necessary to adopt a vigorous program for the construction of some Federal projects, along the lines proposed by the bills introduced by Senator Gore (S. 151) and Congressman Holifield (H. R. 2154). The construction and operation of such projects would, in our opinion, advance the technology and reduce costs to the point that normal business incentives can begin to be effective. The British experience appears to confirm this belief.

We will request an opportunity to make further comments on this subject and on the proposed program of governmental indemnity against reactor hazards at the hearings on these subjects to be held by this committee.

On behalf of the American Public Power Association, I would like to express our appreciation for this opportunity to present our comments on the development, growth, and state of the atomic-energy industry.

(The letters submitted by Mr. Morris follow:)

AMERICAN PUBLIC POWER ASSOCIATION,
Washington, D. C., December 20, 1956.

Hon. LEWIS L. STRAUSS,
Chairman, United States Atomic Energy Commission,
Washington, D. C.

DEAR MR. STRAUSS: We were very much interested in your recent address to the American Nuclear Society and in your proposal that the Atomic Energy Commission in the near future issue a third invitation for proposals under the power reactor demonstration program.

As you know, the membership of this association is strongly interested in participating in the program although we believe that some Federal projects also will be required for optimum progress in atomic power technology.

I should like to urge very strongly that, in considering a third invitation for proposals, the Commission assure itself that the terms of the invitation are such as to allow the nonprofit, consumer-owned electric utility systems like those comprising the membership of this association a full opportunity to continue to participate in the program.

I feel some concern about the omission in your recent speech of any reference to AEC financial assistance with demonstration reactor construction costs in connection with the proposed third round. If the third invitation for proposals were to exclude any AEC financial participation in reactor construction financing, it would be very difficult for members of this association to make proposals to the Commission unless the invitation were to offer other forms of assistance sufficient to offset the lack of aid on construction.

The Commission recognizes, I am sure, that the local consumer-owned electric systems are not asking for something for nothing, and have no desire that AEC subsidize these demonstration plants to the extent that the sponsoring utility obtains power at a net cost below its normal costs. However, as you know, the nonprofit utility systems differ markedly from the privately owned systems in respect to financial ownership and control and also have more limited financial resources. If the third invitation is to avoid discrimination among the privately, publicly, and cooperatively owned systems, then its terms must recognize and accommodate these differences.

Keeping the way open for continued participation by the local publicly owned utilities would be of benefit to the technical quality of the United States development program, if experience under the first two invitations is any guide. It is generally agreed that the proposals submitted by the Consumers Public Power District and the municipal utility systems of Piqua, Ohio, and Holyoke, Mass., are for plants of advanced and highly promising design which, if carried forward, will make substantial and unique contributions to the technology of nuclear power production. Although progress on the negotiations on these proposals has seemed slow, we are hopeful that contracts will be concluded and the projects will materialize so that the expected technological gains will in fact be realized.

I believe that the Commission could anticipate equally constructive proposals from the local nonprofit systems if the terms of the third AEC invitation make it possible for them to participate.

We recognize, of course, that the Commission can extend assistance only to promising developmental projects and that the program is not designed to assist with the construction of a power reactor for every utility that may desire to have one in its system. Assistance on construction costs for acceptable developmental projects would greatly facilitate participation by the local consumer-owned systems. If it is not to be afforded, I should like to raise for Commission consideration the question of what other provisions are to be made which will enable both the publicly and privately owned segments of the electric utility industry to participate in the proposed third round of the demonstration program.

Sincerely,

ALEX RADIN.

UNITED STATES ATOMIC ENERGY COMMISSION,
Washington, D. C., January 31, 1957.

DEAR MR. RADIN: Among the first pieces of mail brought to my attention after Christmas was your most thoughtful letter of December 20, 1956, com-

menting on my proposal for a third invitation under the power demonstration reactor program.

The Commission had already taken action on this proposal before the other members and myself had received your letter. The result of this action has been, as you know, the issuance on January 7, 1957, of an invitation for demonstration proposals.

We are most appreciative of the interest and offers to participate in the power demonstration reactor program evidenced by members of your association and other consumer-owned electric utilities. Our reluctant decision not to proceed with the project proposed by the municipal system of Holyoke was based on engineering considerations completely outside the control of Holyoke. We would welcome further interest on their part in this program.

You may recall from public comments made from time to time by me and others associated with the Commission that we believe it is in the best interests of the public for the development of peacetime uses of atomic energy to be undertaken and supported to the maximum feasible extent outside of the Federal Government. Such a procedure would result on the one hand in reduced costs to the Nation's taxpayers and on the other to utilization of industry's ingenuity and resourcefulness under the incentives of commercial activity. In carrying through to completion the development, construction and initial operation of the first generation of nuclear power plants employing reactor concepts which have been proved technically feasible under the Commission's experimental reactor program, proposing organizations would, of course, be in a position to benefit from the results of the very considerable effort the Commission has expended on this program. Such benefits would accrue to utilities, both private and consumer-owned, as well as to manufacturers and designers.

In recognition of the probable additional expenses associated with translating the Commission's experimental findings to full-scale powerplant applications, and the likelihood that such expenses may be beyond the capacity of many industrial organizations to absorb, the Commission, in developing conditions for the third invitation under the power demonstration reactor prgram, decided to include consideration of the granting of research and development assistance, either in its own facilities or through support of private efforts, such assistance to be applicable not only to preconstruction phases but also to the early years of operation when certain experimental costs might be encountered relating to improvement of fuel elements and reactor components and improvement in operating and maintenance techniques. It was concluded that these forms of assistance, plus the accumulated benefits of the Commission's experimental program, could well prove sufficiently attractive to result in substantial responses from consumer-owned as well as privately owned activities.

In the 2 years that have elapsed since the inception of the power demonstration reactor program many design and construction firms have accumulated a great deal of knowledge and experience leading to more precise determination of the costs of reactor and fuel element fabrication. It is anticipated that this accumulation of knowledge will enhance their ability to participate with utilities in the preparation of demonstration nuclear power plant proposals which, if carried through to completion, would contribute to expansion of the reactor manufacturing industry.

I trust the above comments will be of help to you.

Sincerely yours,

W. F. LIBBY
(for Chairman).

Mr. ALEX RADIN,
General Manager, American Public Power Association,
Washington, D. C.

The CHAIRMAN. Thank you very much, Mr. Grahl.

Have you included in your statement recommendations for amendments to the monopoly provisions?

Mr. GRAHL. We have not submitted specific language, Mr. Chairman, but we can supply some suggestions to be added to the record.

The CHAIRMAN. I believe it would be well to do that, and they will be included in the record if you will do so.

Thank you very much.

(The information referred to follows:)

AMERICAN PUBLIC POWER ASSOCIATION,
Washington, D. C., March 14, 1957.

HON. CARL T. DURHAM,
Chairman, Joint Committee on Atomic Energy,
United States Capitol, Washington, D. C.

DEAR MR. DURHAM: I deeply regret that last-minute developments prevented my appearing before your committee in February, as scheduled. I understand that after Mr. Grahl, assistant general manager of the association, presented my statement to the Joint Committee on February 21, 1957, you asked me if we could propose for inclusion in the record the specific language of amendments to the Atomic Energy Act of 1954 to strengthen the antimonopoly provisions as rocemmended in my statement.

The American Public Power Association has a very direct interest in seeing the atomic power reactor industry develop with a minimum of monopolistic tendencies. If it comes to be dominated by a few large firms, with a consequent lack of competition in the classic sense, utilities interested in the purchase of nuclear powerplants will doubtless be adversely affected.

We do not pretend to be experts in antitrust legislation and it was for this reason that my statement recommended consideration by the Joint Committee of the amendments which might be needed and did not propose specific amending language. However, in response to your request, I am glad to suggest amendments which we would consider desirable.

We would suggest the following two amendments to the act, in the interest of strengthening the antitrust provisions:

1. Amend the first sentence of subsection 105 (c) by adding the words "or section 104" as indicated below:

"(c) Whenever the Commission proposes to issue any license to any person under section 103 or section 104, it shall notify the Attorney General of the proposed license and the proposed terms and conditions thereof, except such classes or types of licenses, as the Commission, with the approval of the Attorney General, may determine would not significantly affect the licensee's activities under the antitrust laws as specified in subsection 105 (a) * * *."

2. Amend section 105 by adding the following new subsection:

"(d) Where activities under any license or construction permit might serve to maintain or to foster the growth of monopoly, restraint of trade, unlawful competition, or other trade position inimical to the entry of new, freely competitive enterprises in the field, the Commission is authorized and directed to refuse to issue such license or permit or to establish such conditions to prevent these results as the Commission, in consultation with the Attorney General, may determine."

As you will recognize, the proposed additional section (d) is substantially the language which was contained in the Atomic Energy Act of 1946 but omitted from the Atomic Energy Act of 1954.

It seems to us that the amendments proposed above would give the Atomic Energy Commission and the Attorney General needed additional authority to take effective action to prevent the development of monopolies and anticompetitive situations in this new and potentially very large industry. The importance of effective preventive action has been stated eloquently by Attorney General Brownell, who declared in an address of January 24, that "Preventive action must be applied wisely and well if we are to realize the great potential of this new industry for our future industrial well-being. For we are dealing here with a promise of future energy supply greater than all the unmined coal, all the untapped oil, and all the hydroelectric capacity now existing in the United States * * *."

In addition to the antitrust problem in the manufacturing industry with which the proposed amendments are concerned, my testimony called to your attention the fact that, in the utility field, there are large private utility combines being formed in virtually all sections of the country with enthusiastic encouragement and in some cases financial assistance by the Atomic Energy Commission. This matter in our opinion warrants serious and prompt consideration by the Joint Committee.

Sincerely,

SAMUEL B. MORRIS.

The CHAIRMAN. The committee is adjourned until 10 o'clock Monday morning, February 25, at which time we will reconvene in the Senate District of Columbia Committee Room, room P–38 of the Capitol.

(Whereupon, at 12:07 p. m., Thursday, February 21, 1957, the committee was recessed, to reconvene at 10 a. m. Monday, February 25, 1957.)

DEVELOPMENT, GROWTH, AND STATE OF THE ATOMIC ENERGY INDUSTRY

MONDAY, FEBRUARY 25, 1957

CONGRESS OF THE UNITED STATES,
JOINT COMMITTEE ON ATOMIC ENERGY,
Washington, D. C.

The committee met at 10 a. m., pursuant to recess, in room 219, Old House Office Building, Hon. Carl T. Durham (chairman of the Joint Committee), presiding.

Present: Representatives Durham, Holifield, Cole, Price, Dempsey, Van Zandt; Senators Anderson and Dworshak.

Also present: James T. Ramey, executive director, George E. Brown, Jr., David R. Toll, professional members of the staff and George Norris, Jr., committee counsel.

The CHAIRMAN. The committee will come to order. On Tuesday of last week the Commission was before us and did not finish their presentation. So we are continuing today with the questioning by the committee.

I believe Mr. Strauss was a witness at that time and some of the members said that they had additional questions they would like to direct to him.

So this morning we will hear Mr. Strauss first.

Mr. Strauss, I believe at the time we stopped Senator Gore was questioning you. He is not here this morning.

Mr. Cole, have you any questions?

Representative Holifield, have you any questions?

STATEMENTS OF LEWIS L. STRAUSS, CHAIRMAN; DR. W. F. LIBBY, MEMBER; THOMAS E. MURRAY, MEMBER; AND HAROLD S. VANCE, MEMBER, AND MEMBERS OF THE STAFF, UNITED STATES ATOMIC ENERGY COMMISSION

Mr. STRAUSS. I might say, Mr. Chairman, that I believe Senator Pastore asked that when we returned today we be prepared to comment upon the statement made by our colleague, Commissioner Murray.

Commissioner Vance and Commissioner Libby, who have not yet had an opportunity to testify, have come here today with statements on the principle by which we conduct our program in the development of atomic energy for peace, principally in, this instance, for power. I need only add that I am in agreement with this principle and that, as of the last meeting at which the issue arose before our late col-

league, Dr. von Neuman, was incapacitated, our vote on the various applications of this principle has been consistently 4 to 1.

These statements by Commissioner Libby and Commissioner Vance are available to you, sir, when you call for them.

The CHAIRMAN. Thank you very much, Mr. Strauss.

Senator Pastore is not here this morning. So I suppose we will have to postpone his questions until a later date.

Mr. Holifield, have you any further questions of the Chairman of the Commission?

Representative HOLIFIELD. Yes.

Mr. Strauss, I refer you to your statement on page 17 of your statement to us of last Tuesday, where you speak of the private firms furnishing different kinds of materials for fabrication of fuel elements.

Now you state there that the Commission has almost withdrawn from the field of fabricating fuel elements for private projects.

This would indicate that you are now depending upon commercial firms to do this work; is that right?

Mr. STRAUSS. That is substantially correct, sir.

Representative HOLIFIELD. What is the comparative economic basis of the services they are rendering to that the Commission itself rendered heretofore?

Mr. STRAUSS. By comparative economic basis, Mr. Holifield, do you mean the difference in the cost of the service that they are rendering?

Representative HOLIFIELD. Yes; to the consumer?

Mr. STRAUSS. I would like to see whether there is anyone here who can respond to that because the consumers, who have required this service, have not until now been private consumers.

Dr. Davis, the Chief of the Division of Reactor Development, will give you an instance.

Mr. DAVIS. The only instance I can quote offhand and I do not recall the precise numbers, is in the case of the MTR fuel element where they were originally manufactured by Oak Ridge.

We went out and got competitive bids for manufacture of these fuel elements. The contract was awarded to Babcock & Wilcox and at a cost which was somewhat below our cost of manufacturing at Oak Ridge.

So we actually saved money as well as getting private industry making fuel elements.

Representative HOLIFIELD. You do have accurate cost estimates of the Government operation, do you?

Mr. DAVIS. In this case we were comparing the quite accurate cost history of manufacturing these fuel elements at Oak Ridge with firm price estimates from the vendor.

Representative HOLIFIELD. Maybe I should revise my question to ask you what is the difference between the present commercial price, if that has been established, for these fuel elements, and the established history of the cost by the Government?

Mr. DAVIS. For these particular fuel elements?

Representative HOLIFIELD. Yes.

Mr. DAVIS. I can supply the numbers for the record. It is my recollection that that amounted to a saving of something like 20 percent.

(The information referred to follows:)

COMPARISON OF MTR FUEL ELEMENT COSTS FROM GOVERNMENT AND PRIVATE FACILITIES

MTR fuel elements were originally produced at ORNL which supplied such assemblies until July 1, 1956, when a contract with Babcock & Wilcox Co. for supply of these items became effective.

This was the first AEC venture in procuring reactor fuel element fabrication on a fixed price basis and was in accord with the Commission's industrial participation policy. This action was taken when the fuel elements had been produced in quantity and passed the development stage so that specifications could be fixed for production-type manufacture.

Babcock & Wilcox are supplying the fuel elements under a subcontract with Phillips Petroleum Co. The invitations were circulated to 47 potentially qualified companies and a total of 12 proposals were received.

The Babcock & Wilcox bid price of $279.28 per fuel element was the lowest received. The then current Oak Ridge National Laboratory cost was $320 per element as calculated without the AEC 15 percent overhead allowances. With the overhead allowances the Babcock & Wilcox price is about 32 percent lower than the most comparable Government price.

Representative HOLIFIELD. That the private companies cost is 20 percent less than your estimated Government cost?

Mr. DAVIS. Our actual direct cost, including in this presumably profit, overhead, and things of that sort.

Representative HOLIFIELD. So there is no subsidy involved in bringing in these private companies into this field?

Mr. DAVIS. Not in my opinion, sir.

The CHAIRMAN. Doctor, what was the experience at Argonne with the boiling reactor?

Mr. DAVIS. Those fuel elements were actually made in this case by the Argonne National Laboratory themselves. They had in this case gone out and tried to get some proposals and had not been able to get any that they thought were acceptable for this particular first charge in this experimental reactor.

However, they do hope to be able to secure these fuel elements commercially later on.

The CHAIRMAN. Did we go so far as to award this contract and then have to do the job ourselves? Was not that the case?

Mr. DAVIS. There were some difficulties, I believe, in getting some of the plates that went into the fuel element. I cannot tell you the full story, but I believe this was in connection with getting some of the plates that would be fabricated into some of the fuel elements.

The CHAIRMAN. Did we go so far as to award the contract to private individuals?

Mr. DAVIS. No, sir; not for the complete fuel element. I can't speak for certainty, but I don't believe so.

Mr. STRAUSS. We will provide a positive answer to that question.

Representative HOLIFIELD. Will you provide also your estimate of the comparison between the cost of Government fabrication and the cost of the two firms here which are apparently doing the work?

(The information referred to follows:)

FABRICATION OF ARGONNE EXPERIMENTAL BOILING WATER REACTOR FUEL ELEMENTS

Fuel elements for the experimental boiling water reactor were manufactured at the Argonne National Laboratory rather than by private contractors because of the experimental nature and schedule of the initial loading and changes in planning that preceded the design of the elements finally used.

The reactor required 918 plates for the first loading. At one stage in planning it was thought that the fuel elements would consist of 350 spiked plates containing a high degree of U–235 enrichment and 568 other plates of natural enrichment. Only one company, Westinghouse, had the required fabrication experience but it was not interested in the work. Another company, Metals & Controls, Inc., was interested and submitted a bid for the spiked plates which was considered too high.

Because of the high bid on the spiked plates and other technical factors, Argonne changed the specifications for all the plates to uniform enrichment. At this point, the time schedule for the reactor did not permit an outside manufacturer to learn and develop a process for the production of the newly specified plates. Accordingly, the fabrication was done by Argonne since it had experimented with and developed the process appropriate for these elements and was able to produce the plates in time for the scheduled operational date of the reactor. The cost for fabricating the 918 plates of uniform enrichment at Argonne was estimated to be only slightly higher than the cost of purchasing 350 spiked plates from private sources, without considering the costs of processing the remaining 568 plates.

Mr. STRAUSS. If we have that information, Mr. Holifield, we will do so by letter.

Representative HOLIFIELD. Now, on page 18 you talk about the processing of fuel elements and you indicate from that page of testimony that up to now you have not been able to get this work done by private industry.

Your second paragraph seems to indicate that you have abandoned the idea of having private industry process fuel elements; is that right?

Mr. STRAUSS. I think "abandon" is too strong a word, Mr. Holifield. This is a matter of timing. We expect and confidently believe that private industry will come into this field.

If you will notice the last sentence in the second paragraph on page 18, we indicate our intention to cancel the contracts which we make on 12 months' notice if and when we find that the required facilities will be available commercially at reasonable prices.

The contracts will contain language making it clear to the contracting parties that this is our intention.

Representative HOLIFIELD. Now, in the meantime, you are signing or offering to sign 10-year contracts through January 30, 1967, at fixed prices subject only to escalation on the basis of a recognized price index.

Now, are they fixed prices based on the actual cost to the Government of recovery of material and taking into consideration, of course, I suppose, the offsetting value of the material that is recovered.

Mr. STRAUSS. Would you answer that, General Fields?

They are as realistic as we can make them.

Mr. FIELDS. They are as realistic as we can make them at this time, sir.

The problem has been to provide industry an assurance of chemical reprocessing at a cost that they would know in advance.

Now, we have determined, on the basis of a plant for processing—and you know these fuel elements will come in all kinds of forms, shapes, and compositions—a means whereby we would estimate what it would cost the Government to process these.

On that basis we will enter into contracts. At the same time, we are proceeding with private industry.

You will recall over a year ago we did solicit industry in the chemical processing end of this activity. We have never gone out specifically for a proposal as yet because of the difficulty of this problem.

Now, what we have come forward with here is a means of arriving at what it would cost the Government to do this, reasonably estimated, as well as we can at this time, and on that basis we would enter into contracts so that the companies that are building reactors may know what it will cost them to have their fuel reprocessed.

At the same time we want to encourage industry as much as we can, but this is a difficult problem and the question here is do you have your powerplant built first? Are you encouraging that, or should you encourage to the maximum extent the chemical processing industry?

You are caught between two problems here.

Now, we are taking what we think is a reasonable approach to this. We hope industry can come close to these prices so that when they get into operation we can determine that their costs would be reasonable and that the contracts that we would have entered into could be canceled on 12 months' notice and the industrial operator would then have to contract for his services.

Representative HOLIFIELD. You have endeavored to arrive at a fair cost?

Mr. FIELDS. We have endeavored to arrive at a fair cost.

Representative HOLIFIELD. Without regard to your objective of getting this program going, you are applying actual accounting cost principles to this to an accurate estimate as possible?

Mr. FIELDS. Yes, sir; with such assurance as we can give at this time.

But with the varying compositions of these fuel elements this has to be the best estimate we can make at this time, and it is subject to being incorrect because it is an estimate.

Representative HOLIFIELD. The real purpose of my question is to find out if the basis for your charges will be on actual cost or will there be a hidden subsidy.

Mr. FIELDS. No, sir; our charge will be based on an actual full cost recovery by the Government. Our normal full cost recovery practice will be the basis of our charge for this service.

Now, in determining whether the charge that industry would make would be reasonable so that it would be a basis for canceling the contracts that we will enter into, our intention is that something within 15 percent of our price, our cost, would be reasonable.

Representative HOLIFIELD. This must of necessity be an open-end estimate because of the different sizes and shapes and so forth of the fuel elements.

Mr. FIELDS. It is based on a plant that we estimate could be built and an operating cost for that plant per day. Then it varies with the fuel elements.

You look at how much treatment it takes, how big the batch is, how often it will be coming in.

On the basis of that, you come up with a specific amount for each type of reactor. The processing cost will vary with the reactor.

In other words, you cannot state a figure like $16 and say that is the price in this instance.

Representative HOLIFIELD. So from the standpoint of cost operation the costs are still in the dark as to what this will be?

Mr. FIELDS. No, sir. Once they fix on their fuel elements you can sit down and negotiate with them specifically how much it will cost to process their fuel.

On the basis of the schedule, they will provide as to the timing of it—when it would be extracted, when it will be processed—you can come to a fixed amount here.

Representative HOLIFIELD. It depends on the determination on their part of the kind of element they want?

Mr. FIELDS. That is right.

Representative HOLIFIELD. Now, on page 19, Mr. Chairman, where you speak of repurchasing plutonium and uranium 233 from foreign reactors fueled with material principally from the United States, would this be on the basis of purchasing it as contained in fuel elements or after it was processed out?

Mr. STRAUSS. Mr. Holifield, certainly for the present it will be in the fuel elements since we are not aware of any reprocessing facilities in existence anywhere else that could achieve this purpose.

Mr. FIELDS. Could I amplify that slightly, sir?

Representative HOLIFIELD. Yes.

Mr. FIELDS. They would pay for the processing—I would like to get this point in—even if we reprocess it. There are certain instances, as the chairman inferred in his remarks, where it may be determined that the fuel could be reprocessed somewhere else provided facilities are built, but they are not in existence so far as we know at the present time.

Representative HOLIFIELD. In the next to the last paragraph you say patent applications relating to atomic energy filed in 1956 by the United States industry totaled approximately 450 as against 135 from 1955 and 1950 and 1954. The question I wish to ask you on that paragraph is:

Has the AEC determined any of these patents to be important enough to assert a United States proprietary interest in them?

Mr. STRAUSS. I would like to ask the General Counsel to respond to that, Mr. Holifield.

Incidentally, we have a general statement on the subject of patents which could either be put in now if the chairman so desires, or later, in this testimony.

Would you respond to the question, Mr. Mitchell?

The CHAIRMAN. Without objection the statement will be included in the record at this point.

Is that a long statement?

Mr. STRAUSS. It is a statement of some considerable length and does not bear on this point, but the patent situation has arisen and I wanted to indicate that we would like to testify on the subject.

The CHAIRMAN. Does this deal with foreign patents, also?

Mr. MITCHELL. My statement, Mr. Chairman, which has been circulated, deals only with foreign patent rights.

(The material referred to follows:)

STATEMENT WITH RESPECT TO FOREIGN PATENT RIGHTS BY WILLIAM MITCHELL, GENERAL COUNSEL, AEC

Certain testimony during the course of the hearings before this committee last week with respect to foreign patent rights suggests that some clarification may be desirable.

Prior to the enactment of the Atomic Energy Act of 1954 the significant contributions to the atomic-energy are were largely classified and no foreign filings of patent applications were possible, except for certain limited arrangements with Canada and the United Kingdom. Since 1954 foreign filings of

patent applications on a classified basis have become possible where the subject matter is included in the provisions of an agreement for cooperation with a particular country which provides for the exchange of restricted data. Furthermore, declassification actions by the Commission have greatly enlarged the areas where foreign filings are possible on an unclassified basis. In the past 2 years the Commission has filed approximately 150 patent applications with various foreign countries, of which approximately one-fifth have been classified, and during the same period United States industrial concerns have filed approximately 100 applications abroad on inventions arising under contracts with the Commission. Prior to 1954 the Commission filed a few cases in foreign countries, including certain Western European countries. These applications are still pending and no patents have been issued.

The Commission has followed the practice of having contractors when reporting inventions indicate whether they desire to file any United States or foreign patent applications. If the invention does not involve classified subject matter, the Commission has promptly notified the contractor to proceed to file the United States and any foreign applications the contractor desires. In instances where restricted data is involved, foreign applications, of course, have only been filed by the contractor or the Commission where the subject matter involved falls within the scope of information exchangeable under an agreement for cooperation negotiated under section 123 of the Atomic Energy Act of 1954 and where it has been ascertained that the subject matter is of sufficient importance to warrant the filing in a foreign country. In those instances where a contractor indicates that foreign filing would be desirable but that its rights in the invention or discovery under its contract with the Commission are not sufficient to justify the contractor itself in so filing, the Commission has ordinarily made the foreign filing after review of the subject matter. Where an invention or discovery is privately developed, as distinguished from work under a Commission contract, there are no restraints on foreign filings by private industry except in those instances where classification is involved; and even where the invention or discovery has some classified aspects the Commission has attempted to work with private industry in making a specification which could be filed on an unclassified basis.

With respect to the effect of publication of information on applications for patent rights in foreign countries, it is true that under the laws in most countries publication in any country prevents the subsequent acquisition of patent rights. (This is not true in the United States, as applications may be filed within 1 year of publication.) However, one of the stated purposes of the Atomic Energy Act of 1954 is to provide a program of dissemination of unclassified scientific and technical information so as to encourage scientific and industrial progress. The Commission does attempt to file, or permit its contractors to file, applications in the United States on significant inventions or discoveries prior to publishing information concerning them. Foreign filings are then possible within a year after the United States filing in countries adhering to the international convention. However, if publication of all information were to be substantially delayed so as to provide an opportunity for private industry to acquire foreign patent rights on developments resulting from Commission contracts, the program of widespread dissemination would be seriously curtailed.

With respect to the suggestion that United States industry should be permitted to obtain foreign patent rights on inventions or discoveries which have been developed as a result of the expenditure of Government funds, the previous testimony does not clearly indicate to us precisely what was intended. If the suggestion is that a particular contractor should be permitted to obtain exclusive rights on such an invention or discovery in a foreign country, with the expectation that the contractor would then make the patent rights available to other United States concerns on a basis of either charging royalties or crosslicensing, it would appear that the contractor has been permitted to obtain an undue advantage over other American industry. On the other hand, if the intention is that the contractor should hold the patent rights in trust for other United States concerns, to be available without charge or cross-licensing, it is difficult to see what additional incentive there would be for a private concern to make the foreign applications. Under the present system, the Commission can and does file foreign applications, if the invention or discovery is considered sufficiently significant to make this desirable. The resulting rights are then available for Government use, including the opportunity to employ the same in exchange

agreements with other countries, and also are available to all United States industry on a nonexclusive and royalty-free basis.

(The following is a communication from Dr. Chauncey Starr, vice president of North American Aviation, Inc., amplifying his testimony before the Joint Committee (p. 211), and commenting on the preceding statement by Mr. Mitchell:)

NORTH AMERICAN AVIATION, INC.,
April 10, 1957.

Hon. CARL H. DURHAM,
Chairman, Joint Committee on Atomic Energy,
Capitol Building, Washington, D. C.

DEAR CONGRESSMAN DURHAM: As part of my recent testimony before your committee, I submitted an exhibit relating to the foreign patent situation in atomic energy. The purpose of this exhibit was to indicate our understanding of a problem that we considered worthy of serious study. We called attention to the present patent policy of the AEC which made it possible for foreign nationals to obtain patents in foreign countries on inventions conceived entirely by American companies. I was requested by Representative Cole at this hearing to submit to the committee a proposed legislative solution to the problem. Accordingly, attached herewith is a proposed amendment to the Atomic Energy Act of 1954. This amendment deals specifically with the foreign patent problem about which we are concerned. It proposes to permit the acquisition of foreign patent rights by Commission contractors, subject to a royalty-free license to the Government.

The question was raised at the hearing as to whether the acquisition of foreign proprietary rights by Commission contractors would lead to a concentration of patents in a limited number of companies. Statutory control over this aspect has not been suggested because it is believed that the public interest will be maintained by the normal checks and balances of a competitive economy. Since a very large number of firms are presently Commission contractors, the patent rights will be widely distributed. No one firm will therefore be in a position to build a dominant patent position, particularly as nuclear technology has now advanced to where only relatively specific patents can be obtained. This will create a situation of interdependence of American firms. In the past where patent rights have been widely distributed in an industry, it has been to the mutual advantage of the industry members to voluntarily exchange patent rights for the benefit of all. Examples may be found in the aircraft and electronics industries. Statutory regulation would inhibit such flexible arrangements in this industry, and, as observed above, is not necessary to achieve the common objective. We further feel that the retention of proprietary rights will provide needed stimulus to the investment of private funds, to compensate for the considerable risks in marketing new developments, and to provide a basis for covering the costs of securing, maintaining, and defending the patents.

I believe it would be useful if a certain point in our statement were clarified and expanded in view of a reply thereto from the General Counsel of AEC. We noted that a search in continental Europe failed to reveal an issued nuclear-energy patent to the Commission, although we noted elsewhere that the Commission has filed in Canada and the United Kingdom. The AEC advises that a number of patent applications have been filed in various foreign countries by the Commission. The Commission speaks only of applications for patents, while we referred to actually granted patents. Patent applications are generally kept secret until such time as they possibly may mature into patents, and, hence, this information is not available to a patent search. However, the Commission statement does not indicate how many separate inventions these patent applications cover; for instance, if each separate invention were filed in 10 countries, this would represent relatively few inventions. Our statement referred to continental Europe, while the Commission's reply speaks of foreign countries broadly. It is likely that the majority of the Commission filing has been in Canada and the United Kingdom. To us, patent protection on the Continent is more essential because England and Canada are developing their own atomic-power industry, and our market potential there does not appear to be great. Our statement on

issued patents plainly had reference to the reactor field and not to technical fields surrounding atomic energy. Since our search did not reveal issued patents in the reactor field on the Continent, most of the Commission's foreign patent applications may be in fringe fields of lesser interest.

The point of this particular statement was not to deal in specific numbers but to indicate a general trend. The purpose was to compare the situation in the United States, where the Commission has filed on many thousands of separate inventions, with that abroad, where, in comparison, the separate inventions filed on have been few. We still believe this to be the case.

We would now like to consider more thoroughly why we consider the Commission is not in a position to undertake an effective foreign patent program. Foreign patents are of value to American industry only if they are enforced. If a mere defensive position is desired, that is, freedom from suit by others on a particular invention, such can be obtained immediately by publication of the invention, since European laws generally bar patenting after publication. We assume that, because the United States Government would not be economically damaged by infringement of foreign patents assigned to it by Commission contractors, it would have no motivation to sue a foreign national or government thereon. The Government would in any event be highly hesitant and possibly embarrassed to sue on its foreign patents, especially in view of the atoms-for-peace program. If an American firm were sued on the basic reactor patents now held by foreign groups, the Government would have little incentive to use patents it holds as a counterforce or for negotiation in defense of the American firm. Even if the Government were so inclined, it would be reluctant for fear of adverse foreign reaction.

We, therefore, can see no reason for AEC to expend public funds in obtaining foreign patents for a defensive position and thereafter paying taxes and a working fee thereon to foreign governments. If the purpose of the Commission in obtaining foreign patents is to permit patent interchange agreements with foreign governments, our earlier comment that previous interchange agreements did not benefit American industry is again applied. In summary, we firmly believe that American industry has the strongest motives and is in a potentially better position to protect itself in the foreign patent field than is the Commission.

We will be very pleased to furnish whatever other information or comments you and the other members of the Joint Committee may wish.

Very sincerely yours,

C. STARR, *Vice President.*

Attachment.

H. R. ———

A BILL TO amend the Atomic Energy Act of 1954

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That section 152 of the Atomic Energy Act of 1954 is amended by adding the following new paragraph at the end of that section: "Notwithstanding anything in this chapter, whenever the invention or discovery is made or conceived under any contract, subcontract, arrangement, or relationship with the Commission to which the Commission has not waived its claim, the maker of such invention or discovery or his successors and assigns may file a patent application thereon in any country outside the United States, subject to security provisions and regulations, and shall retain the entire right, title, and interest in any resulting patent application or patent: *Provided,* That the United States shall be granted, for governmental purposes, a nonexclusive, irrevocable, royalty-free license under any such patent application or patent.

SEC. 2. Section 159 is amended by deleting the word "Nothing" and substituting therefore "Except as provided in section 152, nothing".

Mr. MITCHELL. Mr. Holifield's question at the moment is directed to domestic filing, as I understand it. So far as I know, Mr. Holifield, and I would like to have an opportunity to amplify the record on this, we have not asserted to date Government rights on any private filings on which we have been given notification by the Patent Office.

But I would like to explore this further and supply something for the record.

Representative HOLIFIELD. As I understand it, no patents have been applied for that in the judgment of the Commission were important enough to come under the terms of reservations for the Government account.

Mr. MITCHELL. So far as filings by private industry is concerned. Of course, we have made our own filings.

Representative HOLIFIELD. On your processes in your own laboratories?

Mr. MITCHELL. Or processes that arise out of contracts where we have a right to take the title or part of the rights if we choose to do so.

Representative HOLIFIELD. As I understand it, this No. 450 applies to applications of private industry, however?

Mr. MITCHELL. Yes, sir; and, of course, some of these are still under review.

Representative HOLIFIELD. Has the Government paid private industry for any of these patents? Given them any kind of award?

Mr. MITCHELL. There are some applications for award pending with us, Mr. Holifield.

I think I should point out this: that even where private industry files the application and may get the title, the provisions of our contract will determine the extent to which we have Government rights.

In all instances we at least get a nonexclusive Government license.

Representative HOLIFIELD. That is, of course, where you are operating under Government contract?

Mr. MITCHELL. Yes, sir.

Mr. STRAUSS. In order to be perfectly responsive to your question, there is an instance, and there may be more than one, where an award has been made, or is to be made, to private individuals who have filed patent applications and who are the holders of patents that have been of great value to the Government in years past. I have in mind certain scientists whose names occur to me.

Representative HOLIFIELD. I am aware of those. I was thinking of the operation of the law since 1954. I believe these awards you speak of were before that.

Mr. STRAUSS. The awards were not, but the accounts for which the awards were made occurred prior to 1954.

Representative HOLIFIELD. Now, have there been any important patents withdrawn from the standpoint of security, that is, that have had to do with weapon development?

Mr. MITCHELL. There are some applications on file under secrecy orders, Mr. Holifield. That does not mean that the application is withdrawn; it simply means that the issuance of the patent is deferred.

Representative HOLIFIELD. That is really what I meant.

You spoke more plainly than I did. You mean that claims for patents have been deferred under the exercise of your rights to withhold patents which might affect weapon development in countries antagonistic to the interests of our own Nation?

Mr. MITCHELL. Yes, sir.

Representative HOLIFIELD. I just asked the chaiman if it was all right for me to ask you this question—how many instances has this occurred?

Mr. MITCHELL. I would have to ascertain that and supply it for the record, Mr. Holifield.

Representative HOLIFIELD. Will you furnish that?

Mr. STRAUSS. The number is considerable over a period of time. I take it you are not referring to just the year under review here.

Representative HOLIFIELD. No.

Mr. STRAUSS. We will supply that information for the record.

(The information referred to is as follows:)

UNITED STATES ATOMIC ENERGY COMMISSION,
Washington, D. C., March 4, 1957.

Hon. CARL T. DURHAM,
Chairman, Joint Committee on Atomic Energy,
Congress of the United States.

DEAR MR. DURHAM: Mr. Holifield at the hearing on February 25, in referring to the 450 applications filed by private industry in 1956, (p. 461 of the transcript) inquired whether the Commission had determined that any of these applications were of sufficient importance for the Commission to assert proprietary rights therein. It is desired to note that the 450 applications were reported by the Commissioner of Patents for information and security review under section 151d of the Atomic Energy Act and were not referrals for determination of proprietary interest under section 152. In 1956 there were about 30 patent application referrals under section 152, and as to these the Commission has not filed any directive under section 152. There have been several instances where the Commission has asserted rights in cases submitted under section 152, but after investigation and review the assignees concurred in the Commission's indicated rights so that there was no necessity to file any directive with the Commissioner of Patents. At present there are several cases under review.

The Commission has settled several applications for awards, but the patents or patent applications in such instances, as noted on page 464, were filed prior to 1946. The Commission has paid royalties on several patents owned by private parties prior to the institution of any application for award or just compensation where the patent appeared valid and was used in some activity performed by or for the Commission. There are no applications for awards now pending based on inventions or discoveries made or conceived since the enactment of the Atomic Energy Act of 1954.

As to the number of secrecy orders issued by the Commissioner of Patents at the request of the Commission, as inquired about by Mr. Holifield (p. 465), a review shows secrecy orders issued by the Commissioner of Patents at the request of the Commission and still in effect on 7 of the 450-odd applications filed by private industry in 1956; on 4 of the 135 applications filed by private industry in 1955; and on 8 of the 50 applications filed by private industry in 1954. On Commission-filed applications secrecy orders are still in force on 70 applications filed in 1956; on 42 applications filed in 1955; and on 64 applications filed in 1954.

This will confirm, as stated at page 490 of the transcript, that there is a current workload of foreign filings. The backlog of foreign filings is increasing due to the increased declassification program, however, as foreign patent applications may be filed in international convention countries within a year of the United States filings, there is an opportunity to decrease the backlog during the 1 year subsequent to the current United States filings.

Mr. Cole inquired (p. 492) as to the countries adhering to the international convention. As of January 1, 1957, the 45 countries signatory to the international convention are:

Australia
Austria
Belgium
Brazil
Bulgaria
Canada
Ceylon
Cuba
Czechoslovakia
Denmark
Dominican Republic
Egypt
Finland
France
Germany
Great Britain and Northern Ireland
Greece
Hungary
Indonesia
Ireland
Israel
Italy
Japan
Lebanon
Liechtenstein
Luxembourg
Mexico
Monaco
Morocco
Vietnam
Netherlands
New Zealand
Norway
Poland
Portugal
Rumania
Spain
Sweden
Switzerland
Syria
Tunisia
Turkey
Union of South Africa
United States
Yugoslavia

Sincerely yours,

WILLIAM MITCHELL,
General Counsel.

Representative HOLIFIELD. I notice on page 20 you say that the power bilateral agreement concluded with 6 countries give those countries rights to inventions resulting from any interchange of classified information.

Do we have agreement with more than 6 countries, power agreements?

Mr. STRAUSS. Not at the present time, sir.

Representative HOLIFIELD. It is your purpose, then, to have that type of clause in all bilateral agreements where power is involved?

Mr. STRAUSS. The aim, Mr. Holifield, is to have these agreements as nearly uniform as possible.

Representative HOLIFIELD. I may have asked you this question before in regard to the third invitation to industry to submit proposals. The question was: Have there been any proposals to date under the third round?

Mr. STRAUSS. There have been no firm proposals to date. The invitation has only been outstanding for a matter of something like 60 days, not quite that long.

Representative HOLIFIELD. Now, going to page 24 where the different types of reactors are mentioned in the second invitation paragraph, I notice you referred to overland cargo carriers.

Are we to understand that the Defense Department now has asked for the construction of overland cargo carriers or a nuclear engine that would propel an overland cargo carrier?

Mr. STRAUSS. That was not in my statement, but will you respond to that statement, Mr. Davis?

Mr. DAVIS. What is being done in this case at the present time is a study which is being made for the Department of the Army. These are not development contracts, but merely an exploration of the idea. I

think they have about reached the state where we can sit down and make an assessment as to whether there is any merit to the idea, or not.

Representative HOLIFIELD. I trust that this committee will be kept fully informed on this because I can forsee another fiasco like the 80-ton artillery carrier which turned over in Germany when they tried to turn a corner with it.

Mr. STRAUSS. I am sure, Mr. Holifield, the record as between the committee and the Commission will give you assurance that you will be completely and currently informed.

Representative VAN ZANDT. Is it not true, Admiral, that the study that is being made for the Army Quartermaster Corps is under the auspices of a group of railroads and they are going about it in a very intelligent manner.

Mr. DAVIS. Mr. Van Zandt, that is a separate study. The railroads at their own expense are having a study made by Walter Kidde Nuclear Laboratories, and I believe some others. The sponsors are the New York Central, Denver & Rio Grande, and Baldwin-Lima-Hamilton.

This other study is on a land carrier. It is for the Transportation Corps of the Department of the Army.

Representative VAN ZANDT. Who is making the study?

Mr. DAVIS. I am sorry; I just can't remember offhand.

Representative HOLIFIELD. In deference to my friend, I specifically did not inquire about the locomotives. I was mainly interested in the overland carrier.

Mr. FIELDS. Mr. Van Zandt, I understand on the overland cargo carrier it is the General Motors and Nuclear Development Associates who have combined in making this study on the overland carrier.

Representative HOLIFIELD. Is this a research and development study being financed by the Government.

Mr. FIELDS. It is being financed by the Government as study, but it is still in the study state, sir.

Representative HOLIFIELD. Page 25 at the bottom of the first large paragraph there you say that the AEC has determined that no nuclear powerplant would be allowed in operation anywhere in the United States unless it conforms to the stringent safety requirement established by the Commission.

I am interested in that because I have seen some of the recent studies that have been put out, have sharply lowered the level of allowable radiation.

I am wondering if your regulations are taking into consideration that fact.

Mr. STRAUSS. Mr. Holifield, the safety standards of the Commission are not new in this sense. The Commission has had an advisory committee on reactor safeguards which has been in business for 10 years.

As to your statement concerning the reduction in the standards of radiation hazards, I would appreciate it if you would permit Dr. Libby, who is certainly as expert as any person in the United States, or in the world, on this subject, to comment on that.

Dr. LIBBY. Thank you, Mr. Chairman, for the compliment. I will try to live up to it.

I believe that we can say that our policy is completely consistent in this regard and is in complete keeping with the recommendations

of the National Committee on Radiation Protection, which is the committee that promulgated this set of standards you referred to, Mr. Holifield.

Representative HOLIFIELD. I want to come back to this fact later on, but I will pass it at this time.

Now, your next allusion there is to the disposal of waste products. In the February 17 issue of the New York Times there was an article which treats of the disposal of these radioactive wastes in the deeper parts of the ocean.

The question which I would like to ask is: Have you determined the solution to this problem of disposal of wastes and, if so, have you been able to place a price tag on this service of disposing of waste for these people who plan to have these reactors?

Dr. LIBBY. In the first place, we have had this waste problem for many years, as you know, Mr. Holifield, in connection with the production of plutonium and we have been able to take care of these waste products in quantities quite comparable to the quantities that will be produced by a sizable atomic power industry.

Of course, what we have done is to put the things in tanks and bury them.

Now, this has certain costs associated with it and the problem that is cited is one that I have always interpreted as being one of cost. People have felt that this was too expensive.

I don't believe so. I think what will happen is that the waste products will prove to have values of their own which will defray these storage costs.

So I am really not worried about this problem of disposal as being a major one. It is certainly one that will have to be watched and it is one that we have had lots of experience on.

We do know how to put them in tanks and keep them for years safely. If you come to the time when you can't afford these tanks and burying operation, then it is time to talk about pumping them into the sea and we are making studies about that.

But I don't believe that will be necessary. I think the procedures we have had in times past will be the ones we will want to use.

You see, it is an irreversible process to dump these in the ocean. If you want them again you cannot get them back. If you have them in tanks you can go get them. We have a plant at Oak Ridge which is separating cesium isotopes as a substitute for cobalt as radiation sources. This cesium has a 33-year half-life so the stuff lasts a long time.

If you keep it in tanks you can always go back and get it.

In other words, the waste products may be misnamed. They may turn out to be assets.

I think it is quite logical they will.

Representative HOLIFIELD. Of course, we hope they will. In the meantime, there is substantial cost and also a substantial hazard in the transportation of these materials.

My question is: Have you arrived at a cost tag or a price tag for which you can offer the services of waste disposal to private industry?

Dr. LIBBY. I would suggest Mr. Davis answer that question.

Mr. DAVIS. The chemical processing prices that the general manager spoke about do include the cost of the waste disposal. This waste

disposal that would be included under this cost would be for a period of perhaps 20 years in tanks.

At the same time we are investigating a variety of other ways of disposing of the waste. One of the ways we are investigating is drying of the wastes and storage in tanks, or somewhere where they can be stored dry. There would be no possibility of leaching or leakage of fission products. Investigations are being made of storage in salt domes and various underground formations, and also possible disposal in the sea.

These costs today are fairly substantial. It depends a lot on what the process is and what the fuel element was from which it came.

Zirconium usually leaves you with quite a large volume and a relatively, though not prohibitively, large cost of disposal whereas other materials may be small volume and lower cost.

The costs right now don't seem to be prohibitive, but they are high enough so that we should get them down and get prepared to handle really large quantities of waste in some fairly permanent fashion in the future.

Representative HOLIFIELD. You have not as yet been able to arrive at a formula, cost formula?

Dr. LIBBY. We have it as a part of the chemical processing formula that General Fields mentioned. It again varies depending on the particular fuel element and particular circumstances. It is not so many mills per kilowatt-hour and so many dollars per kilogram.

Representative HOLIFIELD. On page 27, at the bottom of the page, you say the Commission has undertaken a comprehensive study of the potential damage which might result from the nuclear runaway of power reactors.

What is the status of that study now, Mr. Strauss?

Mr. STRAUSS. Mr. Price.

Mr. PRICE. Mr. Holifield, the study was begun last fall, early fall. It is still continuing. I would estimate that perhaps another month or two before it is completed.

Representative HOLIFIELD. You have not come to a conclusion, then?

Mr. PRICE. The problem, sir, is getting help and criticism from a large number of people around the country, both inside and outside the project. We are trying to put this problem in the best focus it can be put in at this time.

Representative HOLIFIELD. Will it be necessary to obtain this before the insurance people can estimate their fees?

Mr. PRICE. I think not, sir, because everybody will recognize both in and outside of the insurance industry that the theoretical possibility of losses in case of a major catastrophe would be for the big reactors in excess of the amount of insurance that will be written anyway.

Representative HOLIFIELD. But they must have some more definite knowledge than they have now on this subject in order to set their fees for the amount that they write; would they not?

Mr. PRICE. I believe the insurance companies are now ready to talk about rates.

Representative HOLIFIELD. But they are not talking about it on the basis of this study. They are talking about it on some other formula.

Mr. PRICE. That is right.

Representative HOLIFIELD. Mr. Chairman, I have here a letter from you to the Chairman of the Atomic Energy Commission, under date of February 19, on this subject. If you think it pertinent, I would ask that it be included in the record at this time.

The CHAIRMAN. Without objection, it will be placed in the record at this point.

Representative HOLIFIELD. Also a letter from the former chairman, Senator Anderson, under date of July 6, to the General Manager, Mr. Fields.

The CHAIRMAN. Without objection, it is so ordered.

(The material referred to follows, together with pertinent correspondence from AEC:)

JULY 6, 1956.

Mr. K. E. FIELDS,
General Manager, Atomic Energy Commission,
Washington, D. C.

DEAR MR. FIELDS: With reference to your letter of June 13 regarding Dr. Libby's testimony before the Joint Committee May 15 on damage from reactor accidents, the Joint Committee would appreciate receiving a more comprehensive report from the Commission on estimated damage caused by nuclear reactor runaways. What the committee requires is a detailed analysis of all pertinent aspects of the problem, with explanations of the basis for the premises and assumptions used. As indicated in the record, we had some doubt as to the use of a 100 percent loss of fission products figure as a basis of estimating maximum loss. It is our understanding that the figures provided were based on a Hanford study. It would appear appropriate that a more comprehensive report on power reactors be provided.

The above information is needed by the committee in connection with its continuing study of radiation hazards and protection of the public against such hazards.

Sincerely yours,

CLINTON P. ANDERSON, *Chairman.*

ATOMIC ENERGY COMMISSION,
August 17, 1956.

Hon. CLINTON P. ANDERSON,
Chairman, Joint Committee on Atomic Energy,
Congress of the United States.

DEAR SENATOR ANDERSON: I refer to your letter of July 6 requesting a study by the Commission of the estimated damage which would be caused by nuclear reactor runaway and the letter of July 27 from Mr. J. T. Ramey requesting information on the status of the report and its estimated date of completion.

As Dr. Libby pointed out in his testimony before the Joint Committee on May 15, we are firmly convinced that the probability of 100 percent of the fission product content of a reactor being released to the environs is vanishingly small. However, the possibility of such an event does exist, at least mathematically, and we felt that, for the purposes of discussions dealing with amounts of needed insurance, it was appropriate to use possibilities without regard to probabilities. The latter were felt to be important in setting rates but not in determining potential liability.

We, of course, recognize that the probable damage caused by reactor runaways, as opposed to the maximum possible damage, depends upon the percentage of the fission products that might reasonably be assumed to be released from the reactor, and the probabilities of such release occurring. The fundamental concept of our system of reactor hazard evaluation is that by applying the best possible technical judgment to all factors of the location, design, and operation of the specific reactor, we are able to conclude that the probability of escape of harmful quantities of radioactive materials has been reduced to an acceptable minimum. Our licensing procedures are such that we will not permit operation of a reactor unless we have reached such a conclusion.

We are aware, however, that the most highly improbable events can occur and we are undertaking a comprehensive study of the probable consequence of the occurrence of such events. This study will, we hope, result in a report which will satisfy your request of July 6, 1956. Due to its complex nature, it is expected that this study will continue, at least in some of its aspects, for many months. However, we feel that a worthwhile preliminary report can be prepared in the next 3 or 4 months, and we are proceeding with such a schedule in mind.

Sincerely yours,

K. E. FIELDS, *General Manager.*

FEBRUARY 19, 1957.

MR. LEWIS L. STRAUSS,
Chairman, Atomic Energy Commission,
Washington, D. C.

DEAR MR. STRAUSS: On July 6, 1956, Senator Anderson wrote, requesting that the Commission make a full study of the damage which could be caused by a runaway reactor. We understand that such a study is in preparation now and will be ready shortly, according to the testimony which has been prepared for the Commission for the 202 hearings.

I would request that this report be made available to the Joint Committee as soon as possible so there can be adequate study of the report, both by the committee and the industrial people concerned, before the hearings, which will be held some time in the middle of March on the indemnity bills.

Sincerely yours,

CARL T. DURHAM, *Chairman.*

ATOMIC ENERGY COMMISSION,
Washington, D. C., March 1, 1957.

HON. CARL T. DURHAM,
Chairman, Joint Committee on Atomic Energy,
Congress of the United States.

DEAR MR. DURHAM: I have your letter of February 19 in further reference to the forthcoming report of the study of potential damage which could be caused by a reactor accident.

According to our present estimates, the report will not be ready by March 15, but all possible efforts will be made to forward it to the Joint Committee at the earliest possible date thereafter. The study itself involves a number of exceedingly complex problems. In addition to the work of our own staff on the study, we have sought the views and opinions of a number of the most highly qualified scientists and engineers and we wish to give full consideration to their suggestions in completing the report.

While we are unable to meet the schedule indicated in your letter, we believe that the additional time required is fully justified to make the report of maximum usefulness both to the Joint Committee and to the Commission.

Sincerely yours,

LEWIS L. STRAUSS, *Chairman.*

Mr. STRAUSS. Is this on the insurance matter?

Representative COLE. I wanted to get some idea what the letter is. I don't have any objection to it.

The CHAIRMAN. I might cite, Mr. Cole, the question was raised in the letter, as to how soon we could have a report so that we could hold hearings on insurance.

Representative HOLIFIELD. Now, on page 28 you speak of the licensing program and you are working closely with the State agencies. This brings up the question of the separation of the licensing and regulatory functions of the Commission from some of its other tasks which have been historical and traditional.

I would like to ask the question—of course, the Commission is aware of the fact that our staff has been studying this problem and I would

like to ask if there has been any thought given by the Commission to the divorcement of this area of duties and responsibilities from the primary duty of producing fissionable material, weapons, and research and development in the peacetime application field.

It seems to me there is a great burden of time and effort that is being placed on the Comimssion. I point to the inevitable controversies which must occur when in the realm of operation of private enterprise. There are always the different interests that are involved, the different pressures, and I am speaking now of legitimate interests and pressures, but which inevitably end up in contests in the courts, litigation such as we have now over the Michigan reactor and the other problems which are coming up which require a great deal of time of the Commission, the preparing of briefs, court appearances, and all that sort of thing.

So I ask if there has been any substantial thought given by the Commission as to the wisdom of making a division in these two different types of functions.

Mr. STRAUSS. Mr. Holifield, the staff of the Commission made an exhaustive and, so far as we were competent to do so, a thorough study of the question to which you have just alluded. Some 5 or 6 weeks ago, we sent to the joint committee a memorandum or study of this subject in which we indicated our conclusion that it would be a mistake to separate those functions among two different groups of men. Our reasons for that view were stated in this study.

Perhaps it might be included here, if the chairman sees fit, as a part of the record.

The CHAIRMAN. I think, Mr. Strauss, we can place that with the study that we are making and not put it in the record.

Mr. STRAUSS. Very well, sir.

Representative HOLIFIELD. Mr. Chairman, I see I have used quite a bit of time. I would like to yield the floor at this time. I have some other questions, but I feel it would be unfair to go ahead.

The CHAIRMAN. Thank you very much.

Mr. Cole.

Representative COLE. Mr. Strauss, in your statement the other day you used an expression which was new to me. In that part of the statement where you outlined the various programs that were under way you said there were seven critical facilities.

I was curious to know, what is a critical facility?

Mr. STRAUSS. Unless the statement was an interpolation of my own——

Representative COLE. It was not.

Mr. STRAUSS. I don't know what a critical facility is. A critical assembly, of course, is familiar to you.

Dr. Davis says that his only definition of a critical facility would be a place in which a critical assembly was conducted and that was the intent of the statement.

You don't recall the particular place and context where it occurred?

Representative COLE. No; I don't. It is in that part of the statement where you enumerated the various programs that were under way.

Mr. STRAUSS. I will have someone try to locate it while we are having this colloquy.

Representative COLE. The first question of a general nature is whether the Commission has any recommendations to make to the Congress with respect to changes in the act.

Mr. STRAUSS. I think, Mr. Cole, there will be a few. I would prefer, however, and I think you would prefer that to the extent possible this come to you in the form of Commission recommendations rather than an expression of my individual opinion.

We are not prepared at this moment to recommend changes in the act. We will have some to suggest.

Representative COLE. My questions this morning are not directed to you as an individual; they are directed to you as a representative of the Commission.

I assumed that any response you make reflects the viewpoint of the Commission.

Mr. STRAUSS. Then my response will have to be, Mr. Cole, that I am not prepared as of this moment to give you the Commission recommendation for changes in the act.

Representative COLE. Are you prepared to indicate the areas, the subject matter, and phases of the act which are under consideration by the Commission for recommendation?

Mr. STRAUSS. Mr. Chairman, if we are to have another opportunity to come before you this afternoon I would undertake to respond to Mr. Cole's question by indicating the areas in which these presumed recommendations will refer.

The CHAIRMAN. It is the intention of the committee that the Commission will be heard again this afternoon.

Mr. STRAUSS. Mr. Cole, if it is agreeable to you, I will try to respond to you on that after lunch.

Representative COLE. Yes.

There has been a good deal of talk by way of complaint against the Commission's operation in regard to failure to declassify restricted data. At the meeting last Monday when this was discussed General Fields, I think it was, said that the only complaint he had heard was from industry, that it was coming out too fast.

Subsequently at the other hearings there was criticism from representatives of universities that that was not so. They were still unhappy with the Commission policies regarding declassification.

What complaints has the Commission had from universities in this field?

Mr. STRAUSS. Mr. Cole, we have had none. I regard the charge as completely baseless. I read the testimony here of one academician, Dr. Parsegian. It is similar to the charges he made in print some months ago and to which I replied at that time. (See p. 185.)

The record of the Commission with respect to declassification of information of a nonmilitary character is, I think—and I say this without embarrassment—quite extraordinary. I had no part in the actual task, which was very large, involving the review of an enormous accumulation of documents for declassification.

As the General Manager testified last week, the only comment that we have had of a carping nature is that the volume of material declassified has defied the facilities of some individuals or small organizations to winnow it.

In that particular we are attempting to do their work for them by briefing and grouping this information so that it can be made more readily accessible.

Representative COLE. One of the complaints of industry which they point to as standing in the way of greater participation in foreign markets in the atomic power field, is the uncertainty of prices to their foreign customers for the nuclear fuel, for the reprocessing of the spent fuels, for the buy-back and so forth.

I think you have touched on it previously, but it was not clear in my mind. Will you take a sentence or two to tell me what the status is now, what price the foreign governments, the foreign users, can anticipate they will have to pay for the fuel, what services are available and prices for the reprocessing?

Mr. STRAUSS. Mr. Cole, as I think you know, American industry is, so far as we are aware, the only industry of any country which has successfully concluded contracts with foreign governments for the erection of reactors.

Representative Cole. How many of those are there?

Mr. STRAUSS. I personally am acquainted with 5 and I understand that there are 2 more. These do not refer to research reactors of which there is a considerably larger number of contracts. These are power reactors.

Representative COLE. Now there are five firm contracts between American producers of atomic power reactors and some foreign purchasers.

Mr. STRAUSS. That is my understanding.

Representative COLE. So far as you know, no other firm contracts between any other national producer of atomic power and foreign governments?

Mr. STRAUSS. Obviously, I am in no position to make a categorical assertion, but I believe, Mr. Cole, that had such contracts been written by industry in other countries we undoubtedly would have heard about it at great length in the press.

Representative COLE. The question was predicated upon the extent of your information. What are the five contracts?

Mr. STRAUSS. There is a contract, I am informed, between an American producer and an Italian public-utility company of quite large size, 1 with Belgian and 3 with Latin American countries. Those comprise the five I have mentioned.

I am told of two more, but I believe that the contracts for them are in such a stage that I might do a disservice to both parties, were I to mention them.

Representative COLE. There are five firm contracts for power.

Mr. STRAUSS. Mr. Davis tells me that a contract with the Dominican Republic has also been announced. I did not know that.

Representative COLE. That makes it six?

Mr. STRAUSS. That is right.

Representative COLE. Firm contracts for power reactors?

Mr. STRAUSS. That is my understanding.

Representative COLE. In various stages of size?

Mr. STRAUSS. That is my understanding.

Representative COLE. Can you tell us the largest and the smallest of those six contracts?

Mr. STRAUSS. The Italian reactor is supposed to have a rating of 134,000 electrical kilowatts and to be a duplicate of the Yankee Power Co.'s reactor which is a pressurized water reactor to be built at Rowe, Mass.

Representative COLE. And the smallest?

Mr. STRAUSS. The smallest I think is 12,000 kilowatts.

Representative COLE. Can you tell us the number of firm contracts between American producers and purchasers abroad for a research reactor?

Mr. STRAUSS. The number will be quite a lot larger.

Representative COLE. Well, approximately?

Mr. STRAUSS. Sixteen as of the moment, Mr. Cole. This number, I should think, will change very rapidly.

Representative COLE. Now, to come back to my original question which started this very interesting information which you have given us, what is the status with respect to the price that the foreign purchaser will pay for the fuel and the availability of servicing the fuel after it is used?

Mr. STRAUSS. Well, the foreign purchaser now knows the base price that he will pay, depending upon the degree of enrichment and the type of fuel.

He also will know, although he does not know at the moment, the reprocessing cost which he will have to pay.

Representative COLE. Those will be determined—the only reason that the foreign purchaser does not know it now is because the Commission has not yet decided it.

Mr. STRAUSS. That is right.

Representative COLE. Which is along the lines you were discussing previously.

Mr. STRAUSS. That is right.

Representative COLE. As soon as the Commission does reach a determination, the foreign purchaser will then know.

Mr. STRAUSS. Yes, sir; I should mention that that has not been a deterrent in the effectuation of the contract I have mentioned.

Representative COLE. Will that include not only the price of servicing the spent fuels, but also the price for the buy-back of the material?

Mr. STRAUSS. The buy-back of the material is, of course, a credit on the books of these companies. The reprocessing charge is a debit. The difference, or balance, will be payable either to them or to the AEC as the chips may fall.

This subject, incidentally, Mr. Cole, may very well be touched upon in the response that we will make this afternoon to your question as to indicated amendments to the legislation.

Representative COLE. These foreign agreements to which you made reference awhile ago, the six power reactors, are all of those with nations with whom we now have power bilateral agreement?

Mr. STRAUSS. No, sir; they are not.

On the other hand, the exchange of information for the erection of a power reactor, if it does not involve classified information, does not require the existence of such an agreement. The transfer, however, of sufficient United States fuel to operate such a reactor is predicated upon the conclusion of an agreement or amendment of an

existing agreement taken between those countries and the United States.

Representative COLE. Can you indicate what ones of the six do not have the bilateral agreement?

Mr. STRAUSS. The only country which at the moment does have one is Belgium, although we are in active negotiations with Italy for a power reactor bilateral agreement.

Representative COLE. Another of the complaints from industry is the uncertainty of their liability with respect to the operation of their reactor abroad. Would you discuss that aspect of the problem of developing a world market for American reactors?

Mr. STRAUSS. Mr. Cole, I think that that is a subject as between the American contractor and the country or the industry abroad which is the purchaser. The Atomic Energy Commission has no direct responsibility with respect to that, not being parties to the individual contract.

Representative COLE. That is true, you have no responsibility, but I am sure you will concur that it does have an interest in assisting American industry wherever it is properly possible.

Mr. STRAUSS. That is right.

Representative COLE. Of course, in the power bilaterals the Commission does have a provision protecting the American Government against any claims from abroad.

I am wondering why those power agreements cannot also and should not contain a provision indemnifying not only the American Government, but any American producer.

Mr. STRAUSS. I can recall no occasion when the Commission has been confronted with or had discussed that aspect of the problem. To the best of my knowledge it has not been raised with us by any American manufacturer. I can recall no occasion.

Representative COLE. I cannot understand why these problems are not tossed at the Commission and they are thrown at us here in the committee without any hesitancy at all.

I don't understand why you folks have not heard about them and we have.

Mr. STRAUSS. I have heard that price and availability of fuel have been discussed, but never the question which you have just raised.

The fact that these contracts which I have mentioned have been made would indicate that it is not, shall I say, a crucial or determining factor.

Representative COLE. Since these sales of American reactors abroad, if they contemplate using American fuel, cannot be consummated without a bilateral agreement, and they cannot be operated except by permission and authority of the foreign government, it would seem to me a perfectly logical and proper condition of that treaty, that agreement, that in case the bilateral agreement is implemented by way of reactor fabricated from American production, that the American producer should be indemnified against foreign claims in the same way that the United States Government, except, of course, where any proven negligence on the part of the American producer, and I would not think that that would be a very difficult clause to be included in the power bilaterals.

Mr. STRAUSS. Well, it might act as a very serious deterrent to American business to obtain these contracts in the face, let us say, of foreign

competition which did not make such a stipulation. But this is a purely personal expression. I would think that as between two reactor concepts of equal merit, where one seller insisted on indemnification and the other did not, the business might go to the man who had the greatest confidence in his product.

Representative COLE. Yes; but do you not fancy that all other governments are going to require the same provision regarding indemnity that we have required?

Mr. STRAUSS. I could not speculate on that, Mr. Cole.

Representative COLE. I am sure you can speculate on it. That is all I am asking, because if I can you certainly can.

Mr. STRAUSS. I think there will be, in general, a disposition to follow our lead. I make that statement with the full realization that the competition in this area will become very keen with the passage of time.

Representative COLE. Yes; and I find one of the major apprehensions of American producers is that they are not only compelled to compete against foreign industrial competitors, but sitting alongside that foreign competitor is the right arm of some foreign government.

What I am trying to do is to develop the right arm of the American Government to sit alongside of the American producer so far as it can be done without jeopardizing the program. It seems to me this is an area where the Commission at least might give some thought to it.

Mr. STRAUSS. We certainly will, and we will discuss this subject with American contractors to learn their point of view.

Representative COLE. Another complaint is that, not so much from industrialists as from the inventor, the Commission has neglected protection of American patents in the foreign market by way of failure to file patent applications in foreign governments; failure to file in foreign countries patent applications made in this country in the atomic field.

Mr. STRAUSS. I have not heard such an allegation. I would like to ask the General Counsel if he has, and if he is prepared to respond to your question, Mr. Cole.

Mr. MITCHELL. Mr. Cole, we have circulated a prepared statement on this subject, which was suggested by some of the points made by your committee last week with respect to foreign patent rights. I don't know whether you care to have me read this.

Representative COLE. This is the statement on patents to which you made reference a while ago?

Mr. MITCHELL. Yes, sir.

Representative COLE. I notice in the statement you say in the last 2 years you have filed 150 patent applications abroad. I think Mr. Strauss' statement was that there are 450 American applications filed.

Mr. MITCHELL. Yes, sir.

Representative COLE. How do you determine which ones shall be filed abroad and which ones allowed to stay at home? How difficult would it be, once a patent in this field is applied for here in the American Patent Office, to automatically file it abroad?

Mr. MITCHELL. I think, Mr. Cole, there probably would be some areas in which foreign filing would not be useful. Let us take, for instance, a patent that has to do with processing raw material or invention or discovery that has to do with it. There probably would not be much to be gained by filing such an application in a country that

had no uranium. Similarly, if it is an invention or discovery that has to do with the complicated manufacturing process, there would probably be little to be gained by filing in a country that has no highly developed industry. You have to be somewhat selective on these things, I think.

Representative COLE. Do you have an organization in the Commission that screens all these applications and currently determines which ones should be filed abroad in order to protect the American inventor?

Mr. MITCHELL. We attempt to do that, sir. Our system is this: When an invention or discovery is reported to us under our contract, as it must be, we ask the contractor to indicate whether or not he wishes to file either in this country or abroad, or both. If he indicates he does not care to file abroad, we make an effort to screen those that look more significant and determine in those instances whether or not the Commission should file abroad, and, if so, where. I cannot assure you that we pick up every one, but we do make a determined effort and we have a system.

Representative COLE. Do you have any backlog of unresolved cases?

Mr. MITCHELL. We have, certainly, a current workload.

Representative COLE. Is it appreciable?

Mr. MITCHELL. I believe not, to the best of my understanding. Where a contractor has said to us, on reporting an invention, he thinks it should be filed abroad, but he does not propose to do it, up to this point after reviewing the subject matter we have filed where the contractor himself said he thought it should be done.

Representative COLE. How do you protect or how can you possibly protect, if at all, the inventor who has a conception which is immediately surrounded by secrecy, and therefore, cannot be a patent issue and cannot be filed abroad?

Mr. MITCHELL. Today a classified invention or discovery can be filed in a country with which we have an agreement for cooperation for exchange of restricted data in that area.

If there is no agreement for cooperation which would cover the subject matter, then, of course, we cannot file abroad on a classified basis.

On the other hand, the declassification actions that the Commission has taken in the last 2 years, and more particularly the most recent one, I think, will make it possible in a very large area to file unclassified applications abroad.

There is one further refinement: If an invention or discovery has some classified aspects, but it is mixed, so to speak, and there are some things in it which we think can be filed on an unclassified basis, we make an effort to work this out with the contractor so that we can pick out the things that can be specified as unclassified and file on those.

Representative COLE. You do not see, or do you see, in the bilateral-agreement route, a method by which American inventors can be protected to some extent, especially those that have an invention that is classified as secret or restricted, against a foreigner filing abroad on the very same thing which may not be secret over there, but which is classified as secret here.

Mr. MITCHELL. I think, sir, that the bilateral agreement does provide a mechanism, to the extent that it calls for exchange of restricted data in the particular area in which the invention or discovery arises.

Representative COLE. The requirement for exchange of information would not necessarily exclude an individual in that foreign country from making application and obtaining a patent on that application?

Mr. MITCHELL. In those countries, Mr. Cole, which adhere to the International Patent Convention applications may be filed abroad within 1 year after filing in this country. So that this gives you a little time, at least as to those countries, to file here first under a secrecy order and then file abroad.

Representative COLE. Are most of the countries of the world in this International Patent Convention that you speak of?

Mr. MITCHELL. I am not sure, offhand. I will be glad to give you the figures if you like as to which countries have adhered to it.

Representative COLE. Now, to get back to Mr. Strauss again, the question was raised as to your attitude toward the international statute for the agency, international agency, and you indicated some displeasure or dislike with certain provisions of that statute, but you did not spell them out.

Mr. STRAUSS. I am sorry, Mr. Cole, if my response was taken to indicate displeasure with the provisions. I said that if I were writing the statute, as of today, there are certain parts of it that I would express perhaps more affirmatively, others more strongly, but I believe I concluded my response to that question by saying that I was thoroughly in favor of a ratification of the statute.

Representative COLE. The changes and wording of the act were not of substance?

Mr. STRAUSS. They were not of substance. They would have provided some reassurance to people who may feel there are not sufficient teeth in the statute as it now stands.

Representative COLE. Charges have been made that this statute is another giveaway part of our Government, that it permits the Commission to give the nuclear fuel to the international agency without charge; is that true?

Mr. STRAUSS. There is nothing in the statute that obligates the Commission to do anything, sir. My understanding is that the Commission could make no gift of any substantial amount of fissionable material to anyone without congressional authority.

Representative COLE. Is there anything in the statute that suggests either by way of inference or innuendo to say nothing of the express language, the thought that the country furnishing the nuclear fuel to the international agency would do so at no cost to the agency?

Mr. STRAUSS. I know of no language in the statute which by interference would convey that belief, Mr. Cole. At the time when the delegates of 80 nations met in New York, the President stated that, of the 20,000 kilograms which he had made available for friendly foreign countries in February of last year, 5,000 kilograms would be made available to the agency on terms to be agreed upon.

That I construed to mean not only price, but other circumstances surrounding the contribution of that amount of material.

Representative COLE. In fact, the international statute is very clear. It says that the terms upon which this material will be furnished will be determined by the Board of Governors of the agency and the furnishing country. So if our country does in the future want to give the material away, it may later on determine to do so, but there

is nothing in the statute, the international statute, nor in the current atomic energy law, which requires it to do so.

Mr. STRAUSS. That is true, and I am glad you have brought up this point because there have been inferences to the contrary in the press, and they are not in accordance with the facts.

Representative COLE. Another of the criticisms of the statute is that by furnishing the initial material we will be in substance providing foreign governments with materials with which to make weapons that might later be used against us.

Is there anything in the statute so far as you know, and I am sure you have studied it thoroughly, which contemplates the use of this material for fabrication of weapons?

Mr. STRAUSS. On the contrary, Mr. Cole, the statute is dedicated to the principle that this material shall be used exclusively for peaceful purposes and all of the safeguards and supervisory mechanics for which the statute provides are designed to that end.

Representative COLE. What are those supervisory mechanics? In substance does it not allow the agency to send its representatives in to inspect the project in the course of its operation intermittently?

Mr. STRAUSS. To account for the material.

Representative COLE. To account for the material, and if the material produced is in surplus to the needs of that project, that surplus material is required to be sent back to the international agency.

Mr. STRAUSS. That is correct, and the installation in which the material is to be placed as fuel must be approved by the agency prior to the provision of the material.

Representative COLE. Has the responsibility which the law places on the Commission to license and to inspect and to supervise these domestic operations resulted in any appreciable increase in your personnel requirements?

Mr. STRAUSS. No, but it will, Mr. Cole.

Mr. FIELDS. It has added none to our requirements in force, but it surely will.

Representative COLE. Can you give us a rough estimate of the number of personnel needed by the Commission to date to do the policing requirements?

Mr. STRAUSS. I would like to supply that for the record, sir, rather than to attempt to give you an estimate.

(The information referred to follows:)

UNITED STATES ATOMIC ENERGY COMMISSION,
Washington, D. C., March 20, 1957.

Hon. CARL T. DURHAM,
Chairman, Joint Committee on Atomic Energy,
Congress of the United States.

DEAR MR. DURHAM: During the 202 hearings, questions regarding the licensee inspection program were raised by Representative Cole and yourself. The replies to these questions are herewith submitted for the record.

Presently, 17 professional personnel are engaged in the performance of inspection activities. Of these, 15 are stationed at several operations offices of the Commission, and are engaged specifically in the inspection of licensed activities in the use of radioisotopes (byproduct material) and source material. Two persons in the Division of Inspection, Washington headquarters, are engaged in the inspection of production and utilization facilities and in the use of special nuclear material. In addition, the Washington division is responsible for development and administration of policies and procedures for inspection of the several activities just mentioned. It is estimated that at the end of fiscal year 1958 the number of inspection personnel will be 58. Of this total, 52 will be stationed in operations offices and will consist of 40 professional and

12 clerical; in the Division of Inspection, Washington headquarters, there will be 4 professional and 2 clerical. It is estimated that cost for personnel services and travel for fiscal 1958 will total $565,000. Some States are cooperating with us, where they have technically trained personnel for inspection of licensees using byproduct material.

Detailed procedure for the inspection of the licensed use of radioisotopes (byproduce material) and source material has been developed. This procedure is now being employed by the several inspection units in the operations offices mentioned above. The objective of the procedure is the determination of the state of compliance of the licensee with provision of title 10, Code of Federal Regulations, section 20, Standards for Protection Against Radiation; title 10, Code of Federal Regulations, section 30 (Byproduct Material); title 10, Code of Federal Regulations, section 40 (Source Material); and any special conditions incorporated into the license. Basically, the objective of the inspection procedure is, of course, to ascertain whether or not operations are being conducted in a safe manner. There are approximately 40,000 material licensees using materials which vary from the innocuous types to those having a significant potential for harm if mishandled. We would like to reaffirm that in the past 10 years during which isotopes have been widely distributed and used, there have been very few incidents involving exposures in excess of accepted standards.

The objective for the inspection of production and utilization facilities is, of course, the same as the objective just discussed. Substantial progress has been made in the development of inspection procedure for these activities. The problem here, however, is somewhat more elaborate and complex because of the following considerations:

1. The variance in the types of facilities and their characteristics which are now planned, or under consideration, or in operation.

2. The widely recognized fact that, because of the present stage of reactor development, complete and detailed standards for design, construction, and operation generally applicable to production and utilization facililties are not yet feasible.

It is considered necessary, therefore, at least for the present, that personnel engaged in the inspection of reactors possess extended experience in the fields of reactor design, construction, and operation.

We believe the present reactor inspection coverage to be adequate.

Sincerely yours,

K. E. FIELDS, *General Manager.*

Mr. FIELDS. I could say that we have a Division of Civilian Applications which is largely concerned with licensing. We have a Division of Inspection. These have grown to over 100 personnel in size.

I would like to supply the precise numbers for the record. This will have to increase as we pick up inspection functions more fully and utilize personnel in our field offices as well as here in Washington.

Representative COLE. I have only one other question. That is to seek your thinking on the extent of provision of law prohibiting subsidies for the advancement and development of a nuclear power program.

As I recall, the limitation says no public subsidy will be used for any license under 103 or 104—104 is the one covering research and development—the very thing that we are trying to encourage, and some are disappointed that it has not proceeded more rapidly.

It occurs to me that perhaps that limitation is an impeding factor in the development and inclusion of more projects for development of power reactors.

Do you find that to be so?

As it stands now, the Commission may participate in any of these developmental projects by way of research contract under another authority of the law, but the Commission is prohibited from making an outright subsidy of so much money and having it authorized as an outright gift given by the Commission to the project for the sole purpose of proving out the concept of furthering development.

Now, if these reactor projects are so extremely costly, which they are, for the size that are needed for genuine power producers, if private capital is hesitant to supply that needed amount because of the uncertainty of the outcome, in view of its being developmental, it seems to me that the public interest could justify the sharing of some of that expense by the Commission, not by way of research contracts and so forth which are indirect assistance—we might not call them subsidies, but they are indirect aid.

Would you comment on that?

Mr. STRAUSS. Mr. Cole, I would be inclined to agree with you were it not for the performance which the power companies from one coast to the other have demonstrated since the last session of the Congress.

At our previous hearing we listed the number of projects which have been initiated since last August. I would all, however, that my view of this subject might be different if the response to the third round invitation should prove to be disappointing.

But I have been very much encouraged by the action of Pacific Gas & Electric and the Northern States Power and the Virginia Duke Co. and the West Penn Co., the American Gas & Electric, and a large number of companies associated with those firms, in organizing the number of projects which were listed before you on last Tuesday, Mr. Chairman.

Representative COLE. Can you now tell me what a critical facility is?

Mr. STRAUSS. These would be facilities in which critical mass experiments are conducted.

Representative COLE. That is what reactors are.

Mr. STRAUSS. No; a reactor is not an experiment. A reactor is a plant in which a fuel load is placed on which critical assembly experiments have long since been run, and the facts are known.

Have I answered your question?

Representative COLE. No. Well, I think you did enough so that I can understand slightly better than I did at first.

Mr. STRAUSS. Perhaps, Mr. Cole, you will permit Dr. Davis to give you a technical response to it.

The CHAIRMAN. Commenting a little further on Mr. Cole's question as to whether or not the act provided you with the authority to give this material away, I believe in the present statement in New York the President said "available." A lot of people misconstrued the word that we were going to give away 20,000 kilograms of material.

Mr. STRAUSS. The clause "on terms to be agreed upon," was included very carefully in that statement, Mr. Chairman, to indicate that it was not at that moment a gift. There were and are a number of people who propose seriously that an amount of material should be contributed without cost to the agency and it is entirely conceivable that the Congress may so decide in the course of time. But there was no promise and no commitment made in this connection in New York.

The CHAIRMAN. You can dot it under the 1954 act, can you not?

Mr. STRAUSS. Not without specific congressional authority.

The CHAIRMAN. Mr. Price.

Representative PRICE. Mr. Strauss, you stated, I believe, that there were six firm contracts, foreign contracts, for American firms to build six reactors for foreign governments. These are firm contracts to what

extent? Is there a schedule on them? Is there a date by which time they must be delivered and placed in operation?

Mr. STRAUSS. Mr. Price, I have not reviewed the contracts. They are made between the purchaser and the seller and the Commission has not reviewed them so far as I know.

Mr. DAVIS. I have not seen them, but I might say I understand the American foreign power have actually firm contractual commitments to buy the reactors, although there are still negotiations required between the countries and the United States.

The Edisonvolta one is essentially a letter of intent to proceed if certain conditions are satisfied.

I do not know the circumstances of the Dominican Republic except here again a power bilateral is required.

In the case of the Belgian one, the contract is not worked out, but they are in the process of negotiating such a contract.

Each one is actually different and in a different stage.

Representative PRICE. Is there anything in existing law that would be a handicap or obstacle to American companies to deliver on these contracts?

Mr. STRAUSS. I know of nothing. On the contrary, in connection with the Belgian negotiation, the contractor was actually prepared to deliver the reactor earlier than a date at which the Belgians were interested in getting it because of its location. The contract as first planned called for the completion of the reactor by April 1, 1958. That plan was subsequently abandoned, but not at the request of the American contractor.

Representative PRICE. You stated earlier in the hearing that the British Calder Hall reactor was primarily a military reactor. Does that mean that the AEC has ruled out the value of a dual purpose reactor for the production of electrical energy in the United States?

Mr. STRAUSS. The Atomic Energy Commission, sometime either in the late fall of 1952 or early spring of 1953, took such a position and it has never changed. The position at that time, Mr. Price, was that plutonium could be produced more cheaply and effectively from a reactor designed for that purpose alone and that power could be produced with a more certain determination of its costs from a reactor which was designed for the production of power and in which plutonium was incidental.

Representative PRICE. Has there been a time limit placed on the third round proposals? What time limit has been placed on the third round proposals?

Mr. STRAUSS. There has been a completion date of 1962, if that is what you refer to.

Representative PRICE. Not only that, but for the submission of proposals.

Do you have a time within which proposals must be presented to be acted upon?

Mr. STRAUSS. The Commission can terminate the invitation whenever it wishes, but we have said we would receive and consider these proposals as they were made without, as in the two previous rounds, having set a date by which they had to be made.

I may be able to correct a misapprehension that has also appeared in print recently. The Commission made no stipulation with respect

to the size of the reactors in the third round, either large or small or intermediate or as to type.

Representative PRICE. When was the last full-scale review held by the Commission of our reactor program and of the different concepts of reactors that fit in our program?

Mr. STRAUSS. It is under constant review, Mr. Price. There is scarcely a week when some aspect of the reactor program is not before the Commissioners, and, of course, it is continually, every hour of the day, before the General Manager and his staff.

Representative PRICE. You say before the Commission. On the Commission is there any person, among the Commissioners, who is qualified to pass technical judgment upon a reactor concept?

Mr. STRAUSS. I don't know that any of us would pose as experts, Mr. Price. The Commission, as you know, acts as a group by majority vote, as the law prescribes, and none of us arrogates special competence in a field.

Representative PRICE. This, then, brings up, just how do you determine what reactors have good prospects. Who determines the selection of the type of reactor that is most feasible for the production of electrical energy.

Mr. STRAUSS. Mr. Price, we think we have a very competent staff, not only in the Commission but in the several laboratories where reactors are being developed. We are in close touch with them. We confer with them frequently. We act upon their recommendations, weighed by our best judgment.

Representative PRICE. When you say within the Commission, do you mean in the Commission here in Washington?

Mr. STRAUSS. Yes.

Representative PRICE. What about the field?

Mr. STRAUSS. We visit field installations and we call in the heads of those laboratories for consultation.

Representative PRICE. Who within the Commission would be the one man directly responsible for the reactor program?

Mr. STRAUSS. The General Manager is directly responsible for the entire program of the Commission, Mr. Price.

Representative PRICE. Let us bring it right down to the reactor program. Who, for instance, would be responsible for the success or failure of a given reactor program who makes the decision to go ahead with a certain type reactor, or to stop such a program?

Mr. STRAUSS. The Commission, of course, has the responsibility for the success or failure.

Representative PRICE. Who within the Commission would be the top man in the Reactor Division?

Mr. STRAUSS. The man principally charged with responsibility for the Reactor Development Division of the Commission is Dr. Davis, but we would not charge him with the success or failure of the program. The responsibility for its failure would be ours and the responsibility for the success would belong to the entire organization.

Representative PRICE. For the purpose of the record, could you not just gave us an idea as to just how you proceed to adopt a certain reactor program, or to eliminate a certain program?

Mr. STRAUSS. Yes, I think I can. I am going to ask my colleagues to interrupt if I do not describe this in a way which they think is compatible with the facts.

Let us take the boiling water reactor, a concept, which, if my recollection serves me right, is some 5 or 6 years old. Perhaps its origins go back beyond that. This concept originated, to the best of my belief, at Argonne.

The Argonne Laboratory is operated by a contractor for the Commission, the University of Chicago. At that time the head of the laboratory was Dr. Zinn, who is well known to you.

The head of the laboratory presumably came to the Reactor Development Division of the Commission for the approval of funds to do work on the experimental boiling water reactor. This experimental work, over a period of years perhaps, was not involved in the actual construction of a reactor at all, but it finally reached the point where it was constructed and it operated successfully.

We ran, as you know, one of those experiments to deliberate destruction to see whether its safety principle was valid.

After reaching that point, the Commission knew without the necessity for a formal vote that this was one of the reactor concepts which it wished to promote.

It consequently built such a reactor at the Argonne and has encouraged contractors to view it as a prototype for reactors which are being built for industry.

Does that answer your question?

Representative PRICE. Yes. I think it is valuable for the record to show how you arrive at these decisions.

Mr. FIELDS. May I insert one statement in this, Mr. Price?

At one point each year the Commission as a body reviews in details and approves wha we call program assumptions. Now, this is done just by the end of January of each year for the fiscal year that follows. This is the definitive approval of the broad program on the basis of which the budgeting and funding goes forward and the planning of programs.

But prior to that, all of the work that the Chairman has described has been going on and goes on continuously.

Mr. STRAUSS. Mr. Price, it is like determining the moment at which you fell in love with your wife. Obviously there was a moment at which you proposed matrimony, but the process of becoming acquainted and becoming convinced runs over a long period of time and you can't bracket it by dates.

Representative PRICE. Admiral, just where do we stand on the 5-year reactor program which was submitted to the committee at its request almost 5 years ago? How many of the reactors in that program have been carried through and how successful have they been and have you been forced to drop any from that program?

Mr. STRAUSS. Dr. Davis, who is responsible for that program to a large extent, will respond.

Mr. DAVIS. The EBWR which, as you know, is one of those five, is now in operation. The Shippingport reactor which is another one of the five, will be in operation this year.

The homogeneous reactor experiment No. 2 at Oak Ridge, which is another one, has been held up, as you know, for about a year by difficulties with corrosion.

The sodium reactor experiment at Santa Susana, the fourth one in the program, is scheduled for operation some time this spring, and

the fast breeder reactor EBR No. 2, is cheduled now for operation in 1959.

Representative PRICE. Since that time has there been any new concept of reactor which was not included in the original program?

Mr. DAVIS. Yes, we are doing work on the organic moderated reactor experiment. This is a feasibility-type experiment, which should be in operation this spring.

We are currently in a stage of preparing a design and plan for a liquid metal fuel reactor experiment. We are doing work at Los Alamos on a fast reactor fueled with a moulten plutonium alloy and there are a number of others which are still in less definitive stages, I would say.

I think those are the principal ones, sir.

Representative PRICE. What is the status of the merchant ship program?

Mr. STRAUSS. Mr. Price, you know, of course, that we had a year's delay with that program for which no one is responsible. At the present time, the responsibility for its construction is divided by agreement between the Maritime Administration for the hull and the Commission for the propulsion plant.

Is there anyone here that can respond as to the exact status?

Mr. DAVIS. In the propulsion plant we are currently in the last stages of negotiating a contract for the manufacture of the reactor and the propulsion plant. The design work has actually been going on for some time now under an interim arrangement so that we believe that the propulsion plant at least is in pretty good shape.

Representative PRICE. What type of reactor?

Mr. DAVIS. This will be a pressurized reactor, 20,000-shaft-horsepower output.

Mr. STRAUSS. Had the law permitted us to use the type reactor which is in the *Nautilus* and for which there was some material available, we could have produced a merchant ship at an earlier date, but not of the specifics of the one which is now being built.

Representative PRICE. You would not have gained anything.

Mr. STRAUSS. This project does not prove anything either, except that a surface ship can be run by nuclear power.

Representative PRICE. Is it supposed to be an advance design?

Mr. STRAUSS. There is bound to be some advance on anything that is built today even on the same pattern as one that was built a few years ago.

Another *Nautilus* built today would not be precisely the same in all respects as the first *Nautilus*.

Representative PRICE. Of course, we hoped that you would have an advanced design of the ship reactor that would provide for advancement of the art. We knew that the use of the *Nautilus* reactor in a ship's hull would not add to our knowledge.

Mr. STRAUSS. Had speed been the primary requisite that would have been indicated as the thing to do.

Representative PRICE. Of course, we felt that if speed should be primary there it should be primary in other places, too, like the atomic-powered aircraft.

That is all I have, Mr. Chairman.

The CHAIRMAN. Senator Anderson.

Senator ANDERSON. I was somewhat interested in seeing a copy of the transcript of the 19th, of a hearing which I did not have the privilege of attending.

Senator Gore was asking about this subject of dual-purpose reactors. He said:

> Certain members of this committee have long urged the necessity for dual-purpose reactor in this country.

Your reply was:

> I was not aware of that fact. I naturally accept your statement. The Commission some years ago before I returned to it, took a position which I believe to have been a sound one, that the dual-purpose reactors do not belong in our reactor complex.

Have you been familiar with the report that our committee filed on what has been known as the Gore-Holifield bill?

Mr. STRAUSS. I am sure I must have read it, Senator.

Senator ANDERSON. We sent a hundred copies over to the Commission. I would hope that one would come to you.

Mr. STRAUSS. I am sure I did read it.

Senator ANDERSON. Did that mention the Hanford reactor, a heavy water reactor and various other types?

Mr. STRAUSS. I cannot recall from memory what it said.

Senator ANDERSON. We also said that we would like a reactor concept, that represented variation on existing reactor technology, developed for the production and development of special nuclear material.

I was just a little concerned by it because when the Commission came up Senator Jackson asked questions. I am looking now at page 17 where he was asking Mr. Vance, and you will find it on the hearing of June 28.

Senator Jackson says:

> The only reason it was in there is because if you build a dual-purpose reactor, you would want to utilize the supporting resources, the fabrication and so on, and the chemical processing plants that you have. That was the only thing I had in mind. It would be uneconomical to do it otherwise.
>
> Representative HOLIFIELD. I was not here when 3 (c) was discussed. Would it be out of line if I would ask why the argument or why that particular section was objectionable to the Commission.

Did Mr. Vance communicate to you the fact that there had been any discussion that day about dual-purpose reactors?

Mr. STRAUSS. I am satisfied, Senator, that Mr. Vance and I must have discussed the hearing in some detail.

If your point is that I did not recall an occasion when the Joint Committee was on record as favoring a dual-purpose reactor, I am sorry. The rest of my statement stands, to the effect that the Commission took this position, in the spring of 1953, I believe.

As a matter of fact, within a week or two of my return to the Commission in the summer of that year, I questioned the decision and said so publicly. I think I said so before your committee.

But with the passage of time I am satisfied that the Commission's decision that spring was a correct one and that a dual-purpose reactor does not fit into the policy which we have adopted of making plutonium as cheaply as we can make plutonium and making power as cheaply as we can make power since a dual-purpose reactor will do neither in the opinion of our engineers.

Senator ANDERSON. Now, may I call your attention to your testimony before the Appropriations Committee last year when I was questioning you on this subject. This is at page 64 of the appropriation hearings of last year. I said to you:

> And we might get up to that or more in the course of the next few years. I am wondering what you are going to do with this production if we do not use it up and if we do use it up might it not be profitable to use it in dual-purpose reactors?

We were talking about the uranium situation which was becoming difficult then and is far more difficult now as uranium appears to be running out of our ears and is causing some concern.

I mentioned dual-purpose reactors to you. Your answer was:

> Senator, the Commission decided sometime in the spring of 1953 that the dual-purpose reactor approach was not a sound one from the point of view of the production and development of the economic power. When I became a member of the Commission, in the summer of 1953, I questioned the soundness of that decision by the Commission, but in the winter of 1953–54, when the General Electric Co. made us a proposal for the dual-purpose reactor at Hanford, I was not able to carry the point.

Am I to understand by that that you were a protagonist of the dual-purpose reactor?

Mr. STRAUSS. I was, and I told you that I was no longer, and I am no longer. I have not been for 3 years, which is the period involved here, because I believe the engineering decision that power can be made more cheaply from a reactor which is not specifically designed to produce plutonium as a primary or as an equal product.

Senator ANDERSON. If you had been against it for 3 years, may I just again call your attention to your testimony of last year, when you said:

> I was not able to carry the point, and we have no dual-purpose reactor program. I have personally long been an advocate of a trial. You don't know how much satisfaction you are affording me.

meaning by bringing it up.

Why did I afford you satisfaction for the dual-purpose reactor if you were against it?

Mr. STRAUSS. For the simple reason one likes to have his views seconded, whether or not in point of time.

Senator ANDERSON. It was not the fact that the joint committee had decided to report out a bill with a dual reactor in it that changed your mind?

Mr. STRAUSS. No; I think it was pretty clear that my opposition to the bill that the joint committee was reporting out was well known. I had made it known to you, in any case, sir.

Senator ANDERSON. Yes; but I mean just a few weeks before we reported it out you were very grateful that somebody had brought up again this question of dual-purpose reactor that you had supported.

Mr. STRAUSS. I think the question of a dual-purpose reactor should be continually before the Commission and debated with the view toward determining whether at some future date the engineering case against it may or may not be valid.

Senator ANDERSON. May I call your attention to the next exchange? I said:

> I am trying to furnish you more satisfaction and I hope I have a couple of converts here today.

I was looking directly at Dr. Libby and Mr. Vance, who were with you in the room. That would give you a majority of the Commission.

You said:

> In any case, it is certainly one of the things that we have been very vigorous in exploring. I think that it does offer a weapons-material incentive. I doubt whether it offers the path to economic nuclear power.

Mr. STRAUSS. It seems to me that is consistent with what I have been saying, Senator. If it affords you any——

Senator ANDERSON. Go ahead.

Mr. STRAUSS. No.

Senator ANDERSON. Do not state them privately. Put them out in the open.

Mr. STRAUSS. I do not have the context of these papers before me and therefore you have some advantage, but everything you have said, I think, is consistent with my testimony this morning and with my previous testimony.

Senator ANDERSON. Are you now against the dual-purpose reactor program?

Mr. STRAUSS. I now believe, Senator, that our engineers are correct in stating that as long as our goals remain, plutonium at the cheapest price that we can produce it and power at the most economic price per kilowatt-hour that we can produce it, reactors specifically designed for each purpose are the things for us to build.

Senator ANDERSON. Would the answer then be "Yes," you are opposed to dual-purpose reactors?

Mr. STRAUSS. No, sir; the answer will have to be as I stated it, sir.

Senator ANDERSON. The answer is one that you will have to interpret 10 or 12 different ways as long as this happens and this happens. But are you for a dual-purpose reactor?

Mr. STRAUSS. I submit, sir, that the answer could only be interpreted as I stated: That at the moment, in the present state of the art, the only way at which we can arrive at the best reactor for power purposes is to build a power reactor in which the production of plutonium is incidental, as it is to all reactors.

Senator ANDERSON. Am I correct in interpreting that as a statement that you are opposed to dual-purpose reactors?

Mr. STRAUSS. At the present moment, I am.

Representative VAN ZANDT. With reservations.

Mr. STRAUSS. With reservations, as I stated.

Representative PRICE. Senator, could I ask a question?

How long has it been since the engineers have reviewed their previous decision on the dual-purpose reactor?

Mr. DAVIS. As the chairman has pointed out, there is a continuing study underway.

Representative PRICE. "Continuing" means a lot of things. It means that they are still thinking about it. They remember that they did review it back in 1953 and they have not found any reason to go into detail on it again, and they are continuing their previous study, or continuing their previous decision, but they have not actually, physically investigated the feasibility of the dual-purpose reactor in the last 4 years.

Mr. DAVIS. Let me say this, Mr. Price: I was at Hanford 2 weeks ago today and went over with the GE staff and the Hanford Opera-

tions Office staff the present status of their development for the improved production reactors, and for power and plutonium reactors. They are continuing this work on a relatively small scale and are continually looking at it.

The last time that I and my staff examined it in detail was 2 weeks ago today and 2 weeks ago tomorrow.

Representative PRICE. Would the engineers for General Electric who proposed the dual-purpose reactor at Hanford 4 or 5 years ago agree with your engineers?

Mr. STRAUSS. I do not know how we could be expected to answer that for the GE engineers.

Representative PRICE. I know. But that is the best way to arrive at conclusions on these matters when you have opposite views. If you have just one set of views, it is not very difficult to arrive at conclusions, which may not be altogether accurate.

Mr. STRAUSS. Dr. Davis tells me that he is prepared to say that he feels it is safe to say that there is no substantial disagreement between ours and the General Electric engineers.

I might suggest, Mr. Chairman, that the committee has in the past retained the services of Dr. Zinn as a consultant on reactor matters, and his views on this subject might have some weight with your committee.

Representative COLE. Mr. Chairman, may I hope to clarify the record and to correct Senator Anderson's statement that the Joint Committee, in reporting out the Gore bill last year, recommended dual-purpose reactors? That was not my understanding. I don't think the bill itself made any reference to indicate an intent to include dual-purpose reactors.

I have examined the report that accompanied the bill and I did not find any indication of an intent of the Joint Committee to recommend dual-purpose reactors. That may have been in the minds of some members who supported it, I don't dispute that, but I do dispute that it was the deliberate intent of the committee to recommend a dual-purpose reactor.

Senator ANDERSON. I don't think the language says you shall build dual-purpose reactors. I quite agree with you, but I think there would be enough legislative history—I would only read page 19 where Senator Jackson said:

> There ought to be one amendment in that language, Mr. Chairman, so as to build a dual-purpose reactor, the Commission should have some authorization in the event it is found feasible to produce specific nuclear material as well as power. The way the language is down at the bottom here should be adequate to cover that authorization.

And I said something about that had nothing to do with that particular section. And Senator Jackson said:

> Look at subsection A under 3.

Mr. STRAUSS. This will take the place, as I understand it, of A, B, and C.

> Senator JACKSON. I understand, but what if you decide to build a dual-purpose reactor? I do not think the language at the bottom of the page would cover that authorization.

So we were trying to get language that would cover the authorization all the way through and make it possible to build a dual-purpose reactor.

I am only trying to say that the committee was trying to indicate to the Commission that they had some interest in it, and the chairman was present when that interest was expressed. The text shows that he was there and participated in the discussion.

Mr. STRAUSS. If you will go back to Senator Jackson's statement on the same page, he said there ought to be one amendment to that language, Mr. Chairman, so that "if you build a dual-purpose reactor."

This was a statement by Senator Jackson, as I would construe it, that he even advocated it. This was to give us some leeway and authority, but I fail to read into this any sponsorship of the consent on the part of Senator Jackson. Perhaps that is what he intended, but that is not so expressed.[1]

Senator ANDERSON. The whole purpose of the proposal was that the Commission might explore various types of reactors, including the dual-purpose reactor. We had 545 or 546 pages of testimony, the so-called Gore-Holifield bill, 545, in which dual-purpose reactors came in very frequently.

When Mr. McCune, of General Electric, was testifying, we asked about the plans he had made for dual-purpose reactors. I said in there:

> And we have been discussing the possibility of a type similar to what the British have done at Calder Hall.

Is that a dual-purpose reactor?

Mr. STRAUSS. That is a dual-purpose reactor with primary emphasis on plutonium production and with power as a substantial byproduct.

Senator ANDERSON. But it is a dual-purpose reactor.

Mr. STRAUSS. Yes.

Senator ANDERSON. I see the British have labeled theirs as such. I thought it was. I only say that we have had some interest in dual-purpose reactors. We had a long discussion of the possibility of building 1 at Hanford and 1 at Savannah River.

If it is desired, we could go through the hearings and the classified hearings that we have and try to pick them out and go over them.

What about this question of costs that I saw popping up in here; additional costs? Would the additional costs at Shippingport run some $20 million, $25 million, $30 million when we get through?

Mr. STRAUSS. To a total of $55 million, but not the difference. That will be the total cost.

Senator ANDERSON. In the beginning it was some $34 million.

Mr. STRAUSS. $37½ million.

Senator ANDERSON. Now it is $55 million.

Mr. STRAUSS. Yes.

Senator ANDERSON. Who will pay that additional cost?

Mr. STRAUSS. The reactor is owned by the United States Government, and the Atomic Energy Commission will pay the difference in cost.

Senator ANDERSON. In the case of the Consolidated Edison reactor in New York, which has jumped from $55 million to $70 million, who will pay the cost there?

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[1] EDITER'S NOTE.—In addition to discussion of dual-purpose reactors in committee hearings and Committee Rept. No. 2390 on S. 4146, the debate on S. 4146 indicated that the dual-purpose reactor concept was contemplated. (See discussion by Senator Jackson at p. 11299, Congressional Record (Daily), July 12, 1956.)

Mr. STRAUSS. Presumably Consolidated Edison, since the Government is not a participant in the cost of that reactor.

Senator ANDERSON. Therefore, if the Government had not used its power and its ability to help finance the construction of these, and Shippingport had been built as a private venture by Duquesne Power & Light, the $19 million excess would have come out of the capital structure of Duquesne Power & Light. Is that correct?

Mr. STRAUSS. No; I am not certain that is so, because I do not know what the difference in the cost of the reactor might have been had it been built with private funds. I suspect, Senator, that there is much more pressure for economy when private industry constructs a facility than when it is done by the Government.

Senator ANDERSON. By private funds; but has the board of directors of the Duquesne Power & Light—I have met most of their very fine people—but would you say they have had more business experience than the Chairman of this Commission, who has had great responsibilities in New York; and the other members of the Commission, Mr. Vance, who has had enormous manufacturing responsibilities; Mr. Murray, who has had long experience in the utility business? Are we to conclude that these members of the Commission could not do as good a job of it as the board of directors of Duquesne Power & Light could do?

Mr. STRAUSS. I don't think that kind of experience is the touchstone. This is building something which has never been built before.

You will recall, Senator, since I think you were a member of the Joint Committee at the time, that when a simple reactor was built at Brookhaven, with no power aspects at all, it cost something like double the amount of the original estimate.

Senator ANDERSON. Precisely. I am trying to say that is not a question of business experience.

I believe that the Commission has an abundance of business experience upon it, and has the advantage of a great many expert people. One of them, employed at a few thousand dollars by the Commission, has gone on to General Motors or the Chase National Bank at a salary 10 times his previous salary. So he must have been a man of some ability, as I think Mr. Davis is, and various other people, such as General Fields.

If a reactor doubles in cost, does not that pose quite a challenge to American industry as they start to get into this program?

Mr. STRAUSS. Yes; except that during this period there has been an escalation in costs of all sorts, not only for something as recondite as an atomic powerplant, but equipment that is standard in connection with plants of conventional character has also gone up in price, and so has labor and everything else.

Now, the extent to which that is a factor in this—the percent of the increase attributable to general escalation—I do not know, Senator. But surely some part of it is attributable to that, and some part to the fact that this is the first plant that has been designed, perhaps overdesigned in some particulars, in order that we may have no regrets, other than moneywise, from its construction.

Senator ANDERSON. You are explaining now how you felt that the Government ought to do something in the development of these earlier plants, rather than jeopardize the capital structures of these corporations?

Mr. STRAUSS. I feel their capital structures have not been placed in jeopardy.

Senator ANDERSON. I do not say that. I simply said if they started to build one of these plants and the cost goes out of sight, that has to come from somewhere.

Mr. STRAUSS. Yes, sir. But it does not jeopardize their capital structure any more than when you conduct farming operations and you find it costs twice as much to build a barn as you had budgeted for it.

Senator ANDERSON. Admiral, I am glad to have that statement. I know that one time a company in which I was engaged lost a terrific lot of money, and I thought it jeopardized the capital structure and so did the accountants. I still think it did.

The Consumers Public District out in Nebraska has contemplated some $24,300,000 in the cost of its plant. Now it is up to $50 million.

If this had been anticipated that that was a utility company, Nebraska Power & Light—if there is such an organization—or some other company, and they had actually proceeded with the construction and they had actually budgeted $24 million to it and found it costing them $50 million, would that have any bearing on their operation?

Mr. STRAUSS. For the record, your figure of 50 is wrong by $10 million. It is something like $40 million.

Senator ANDERSON. We are not home yet.

Mr. STRAUSS. This has been in negotiation for a period of 2 or more years, in the course of which time all costs have gone up.

Senator ANDERSON. I read a statement by a member of the Commission. Did you give that statement, Mr. Murray where you said it was going from $25 million to $50 million? I am not sure; I read some statement, but I thought I read it in your statement; did I not?

Mr. MURRAY. Whatever figures I used there, Senator, I got from our staff.

Senator ANDERSON. Where did you get the figures?

Mr. MURRAY. I got them from our staff.

Senator ANDERSON. The staff surely would not be off $10 million; would it?

Mr. DAVIS. May I explain that? I think I can clear that one up, Senator Anderson.

At present, actual estimated cost based on still quite a series of assumptions, is just a shade under $40 million, and this does include some contingencies. We have also explored the cost at which this could be done under a fixed price and there is some reason to believe that, if one were to actually insist upon a complete fixed price, the cost might be as high as $50 million. Forty million dollars is the present actual estimated cost of the project.

Senator ANDERSON. But if somebody were to contract it, it would run to $50 million?

Mr. DAVIS. If someone were to actually get a fixed-price contract, presumably it would cost nearer fifty.

Senator ANDERSON. Would not a private utility have to get a fixed-price contract?

Mr. DAVIS. Not necessarily.

Senator ANDERSON. You think they would just want to build regardless of how it came out?

Mr. DAVIS. Many utilities build on a cost basis, not necessarily on a fixed-price basis.

Senator ANDERSON. You think when they are building a $50 million powerplant, they do not get subbids on the generators and all the rest of the equipment?

Mr. DAVIS. Yes.

Senator ANDERSON. Contrary to what I have understood the way they operated.

Mr. DAVIS. You can do this either of several ways. You can get a bid on the whole plant or you can get an architect-engineer and a construction contractor, who will then take bids on the component parts of the plant and add these to his total cost.

There are very many ways in which this is done.

Senator ANDERSON. So there was some basis for Mr. Murray's statement.

Mr. MURRAY. This figure of the price would undoubtedly double. It came from the Reactor Division.

Senator ANDERSON. You got this information from the Division.

Mr. MURRAY. That is where this information came from.

Mr. DAVIS. I did not say undoubtedly it would double.

Mr. MURRAY. In my statement, it says first estimate, $25 million for the entire plant has now been doubled.

Senator ANDERSON. You both got your figures from the same place.

Mr. MURRAY. At least I know where I got my figures.

Senator ANDERSON. Now, you mention this normal escalation of cost. Do you recall that Consolidated Edison testified that only $3 million of the $15 million was due to escalation of cost?

Mr. STRAUSS. I did not read the testimony of Consolidated Edison. I do not know what they testified.

Senator ANDERSON. We have a letter on file from them that I thought was available, indicating that only $3 million of the $15 million was due to escalation. Would that strike you as a reasonable statement for them to make, or probably based upon some facts?

Mr. STRAUSS. I would accept any statement from a responsible company like that as a proper statement. I do not know the date of it, or the context or anything else, but I accept it.

Senator ANDERSON. Is it out of context?

Mr. STRAUSS. I do not know.

Senator ANDERSON. Let us try to find the statement.

Mr. STRAUSS. I do not say it was out of context.

Senator ANDERSON. You just inferred it to me.

Mr. STRAUSS. I said, Senator, I did not know what the context of the letter was. Do not try to get me to say something I have not said.

Senator ANDERSON. I am not trying to get you to say something you are not willing to. I would like to find out if there is anybody on the Atomic Energy Commission who believes there is any jeopardy in trying to make the utilities of this country build these plants on a turnkey-job basis, when they themselves have no knowledge of what the costs may finally be.

I know that the General Electric Co. entered into a contract with Commonwealth Edison out at Chicago at $45 million. I imagine they are sweating a little bit at the present time.

Now, these do not just come out of thin air. You yourselves were testifying again on these hearings on the accelerated civilian reactor program last year at page 30. I asked you:

Will these excess costs that you referred to be absorbed by these power companies, or will they be passed on to consumers?

This is page 30 of the bigger volume. The answer was:

The excess costs in any business are included in the product which the business sells.

You understand I completely agree with that statement.

If the General Electric Co., in selling motors, manufactures them at a cost in excess of what their competitors manufacture them for, they are included in the selling price of the motors. It is inescapable that the cost of the product is reflected in the selling price of the product.

Now, if the reactor which Consolidated Edison expected to build for $45 million costs $70 million, will that excess cost be reflected in the electric rates which they may charge their consumers?

Mr. STRAUSS. I cannot answer that, sir. That is a question which I presume will be decided by the power commission with jurisdiction in that locality.

Senator ANDERSON. And if the rating division did not grant it, the $15 million would come out of either earnings or capital structure of Consolidated Edison. Is that a correct statement?

Mr. STRAUSS. However their bookkeeping and income-tax authorities rule—I don't know.

Senator ANDERSON. They would have a hard time not taking it out of somewhere. They could not use printing-press money. It would have to come from somewhere.

Mr. STRAUSS. I certainly accept that; it would have to come from somewhere.

You asked me whether it would come out of earnings or capital account. I simply said I do not know the answer to that.

Senator ANDERSON. If the consumer public district in Nebraska had been a private utility and started to build a $24-million plant and it got only to $40 million, we will take Mr. Davis' lower figure, $40 million—would that have any relationship to the business operation of that company?

Mr. STRAUSS. I would think that if this were a very substantial part of the power they sold, it would have a very marked effect on the rate. If it was a very small percentage of the total power they sold, it would have a correspondingly smaller effect upon it.

Senator ANDERSON. This is an electric cooperative out in Nebraska.

Mr. STRAUSS. My understanding is that it supplies the power for the State of Nebraska, and I had assumed it was a fairly large cooperative, but you undoubtedly have better information than I.

Senator ANDERSON. I just thought, in reference to the comparable plant of Consolidated Edison or Commonwealth Edison, it might not be regarded as one of the larger plants of the country.

Mr. STRAUSS. I do not know, Senator.

Senator ANDERSON. Now, the statement of Mr. Murray has indicated the original estimate for the Rural Electric Power Cooperative plant was withdrawn.

Can you give us any light on that?

Mr. DAVIS. The proposed contractor there withdrew his original proposal and has, as I understand it now, made a new proposal which has not yet in turn been made back to the Commission, but it is for a substantially higher figure.

Senator ANDERSON. Can you give us how much higher?

Mr. DAVIS. I do not know that I can exactly.

It is of the order of a couple of million dollars higher.

Senator ANDERSON. The old one was $6,385,000. Do we understand this one is in the neighborhood of $8 million?

Mr. DAVIS. This is the whole plant. I was thinking here about the cost of the reactor and superheater which originally was $3.7 million maximum cost and it is, while I do not have the exact figure, about $2 million more than that.

Senator ANDERSON. Two million dollars would be up 30 percent.

Now, on the Yankee group in New England, meanwhile, an interim estimate has been made that indicates that the overall cost of the plant will exceed the original estimate of approximately $35 million by a substantial margin.

Have you any idea how much that margin is?

Mr. STRAUSS. Is this addressed to me or Dr. Davis?

Senator ANDERSON. Either one.

Mr. STRAUSS. What are you reading from?

Senator ANDERSON. From the Yankee Atomic Energy Co., a letter dated February 20, 1957.

Mr. STRAUSS. We do not know what that figure will be.

Senator ANDERSON. Have you any idea what it will be?

Mr. STRAUSS. Dr. Davis says he does not have a figure that he feels sufficiently satisfied with to place on the record.

Senator ANDERSON. Who will bear the extra cost in the Yankee project?

Mr. STRAUSS. The sponsoring companies.

Senator ANDERSON. What capital structure does the Yankee Atomic Electric Co. have?

Mr. STRAUSS. The general manager will respond to that, because he has just written a letter to the Joint Committee.

Senator ANDERSON. Not the sponsoring companies behind the company, but the company.

Mr. FIELDS. The company is a corporation formed and sponsored by those 12 companies in Massachusetts.

Senator ANDERSON. I assumed there are participating corporations, but you do not add the collective wealth of the individuals belonging to any corporations to that corporation's financial statement. You take only what has been paid in as capital.

Now, what has been paid in as capital?

Mr. FIELDS. They have paid in $1 million from the sponsoring companies and they have authorized the Yankee to loan $1 million more, which should take care of them substantially for a good part of this year, sir.

Senator ANDERSON. That is $2 million and the company's cost may go up as much as ten or fifteen million dollars. Where does the rest come from?

Mr. STRAUSS. The board of directors of each of the sponsoring companies has voted that they will subscribe up to $18 million of equity in this Yankee Corp., sir.

Senator ANDERSON. Have they laid down the circumstances under which they will subscribe?

Mr. STRAUSS. They have not laid down the circumstances.

There are 6 public-utility commissions through which the 12 different companies do have to get final approval. It is their intention to subscribe to $18 million. The remaining would be by senior security issuances, sir.

Senator ANDERSON. I am sorry, I find that the chairman plans to go into the Yankee situation at a later date. I apologize to the Chairman. I did not know you were going to do that. When I came across the fact that an organization had not put up its money, I realized that you have to have the actual contribution.

Mr. STRAUSS. If they put up the money and it was idle until called for, which might be over a period of more than a year, it would be prudent——

Senator ANDERSON. I understand that no one on the Atomic Energy Commission had examined records of the board of directors of these companies to find the adequacy of the resolutions which they passed. Is that true?

Mr. FIELDS. Yes, sir; that is true.

I have talked to Mr. Webster on this point, sir. We will have this corrected.

Senator ANDERSON. I hope I have had enough business experience to know if a company in which I am a principal stockholder agrees to do something, the bank does not take that as binding until I have produced a proper resolution.

Mr. STRAUSS. The Commission is not in the position of a bank, Senator. It is not making any loan, secured or unsecured, to this company.

I agree with you that we should do this, but the consideration is quite different. These companies are putting up this money and they are responsible companies, and they are not asking us for loan and we are not, of course, endorsing.

Senator ANDERSON. I quite agree with you. I do not raise that point at all. I am merely trying to point out that this business of building this round of reactors is likely to involve these companies in very, very heavy financial obligations.

I do not believe it is any part of the desire of this Congress, and I hope it is no part of the desire of this committee, that all of this exploratory work and preliminary work shall be taken out of 1 of 2 pockets—either the stockholders of the companies or the consumers which they serve.

I have thought it might be a general developmental program in which the Government might participate until they get farther along.

I do not believe I have anything further at this time, Mr. Chairman.

The CHAIRMAN. Mr. Dempsey.

Representative DEMPSEY. No questions.

Representative VAN ZANDT. I would like to delay my questions until after lunch.

The CHAIRMAN. Senator Dworshak.

Senator DWORSHAK. Admiral, recently I read in the press, an Associated Press account originating at Waltham, Mass., as follows:

Great Britain with a running start on the rest of the world will be far ahead of the United States and Russia by 1960 in atomic-power production,

according to a new survey. Predictions published by an organization engaged in electronic production and nuclear research, Raytheon Manufacturing Co., are that the companies of the world then will range in atomic power production: Great Britain, United States, Soviet Union, Czechoslovakia, France, Philippines, Sweden, Canada, Dominican Republic, and Belgium. Britain is listed as heading all in expenditures for power reactors.

In the same period, however, according to the survey, the United States will dominate the field of nuclear reactors for research, testing, and experimenting. The study lists this anticipated atomic power output for 1960: Britain, 1,300 megawatts; United States, 930; Soviet Union, 385; Czechoslovakia, 150; France, 95; Philippines, 60; Sweden, 50; Canada, 20; Dominican Republic, 12½; Belgium, 11½.

Can you give us any comments on that as to the veracity of that survey?

Mr. STRAUSS. I would like to make this observation: Any country can move to the top of that list or higher on the list by announcing a program. These are programs and not realizations. Furthermore, the completion of installed kilowatts of capacity is not a measure of accomplishment, in my mind, and the minds of some of my colleagues.

The number of installed kilowatts which the United Kingdom proposes is directly responsive to the great demand in the United Kingdom for electric energy over a period of the next 10 years, coupled with the unavailability of natural fuels in the British Isles.

If we entered a kilowatt race with any of these countries and wished to build powerplants, we could outstrip them all. That may be eventually what the Congress will desire. It is contrary to what I recommend as the most prudent course of action, which is for us in the United States, since we do not require this type of power as urgently as the British, to concentrate on discovering the most effective and the cheapest kind of power and to build that.

Senator DWORSHAK. But you do believe, in order to justify the huge expenditures and investment made by the Government in research and experimentation of atomic energy, that obviously, to take advantage of it and cash in, we would have to carry out some orderly program for power reactors?

Mr. STRAUSS. Yes, Senator. I think we are engaged in such an orderly program.

Senator ANDERSON. I want merely to point out, Mr. Chairman, that the figure of increase from $55 million to $70 million is in the letter which Mr. Searing, chairman of the Consolidated Electric Co., sent to the committee on February 13. He said:

Obviously if these new dated decisions are to be incorporated in revised designs and construction orders, we must expect some delay and substantial additional cost. On 275,000 kilowatts, we may now anticipate a total plant cost of $70 million rather than $55 million.

I find out that the $3 million figure which was used was delivered to our staff and was not in the record anywhere, and you could not have been expected to know that.

Mr. STRAUSS. He also said that the design capacity has increased. Obviously, if you are increasing the size of any plant, you cannot expect to hold it to the same perimeters of cost.

Senator ANDERSON. That is correct.

The CHAIRMAN. Since that question arose, we have some additional statements submitted to the committee for insertion in the record.

Without objection, these will be placed at the end of the testimony in the printed record (p. 387). The total list of statements is as follows:

Technical Appraisal Task Force on Nuclear Power, James F. Fairman, Chairman.
Consolidated Edison Company of New York, H. R. Searing, chairman of the board.
American Gas & Electric Service Corp., Philip Sporn, president.
American Farm Bureau Federation, Charles B. Shuman, president.
Foster Wheeler Corp., E. W. Mills, president.
Wolverine Electric Cooperative, Michigan, John N. Keen, manager.
Metals & Controls Corp., J. Ottmar, vice president and general manager.
General Public Utilities Corp., E. W. Morehouse, vice president.
Koppers Co., Inc., W. F. Munnikhuysen, chairman of the board.
The Dow Chemical Co., John J. Grebe, director, nuclear and basic research.
Pioneer Service & Engineering Co., Fred C. Kellogg, president.
Atomic Law Institute, Bigelow Boysen, director.
Power Reactor Development Co., Walker L. Cisler, president.
Spencer Chemical Co., Kenneth A. Spencer, president.
Middle South Utilities, Inc., E. H. Dixon, president.
Commonwealth Edison Co., Willis Gale, chairman.
General Electric Co., F. K. McCune, vice president, atomic products division.
Yankee Atomic Electric Co., William Webster, president.
Consumers Public Power District, Columbia, Nebr., R. L. Schact, general manager.
Wilson & Earl, management analysts.

We also have copies available to the Commission.

Representative PRICE. Mr. Chairman, I want to make an observation in connection with the matter that Senator Dworshak brought up.

I think that we would be laboring under a very false impression if we thought that the British were concerned with the development of electric energy through atomic power solely for their own consumption. I think Britain has her eyes set on world leadership in this field. I think that is what we should be thinking about. Evidently Britain thinks it is important to be first. They believe there is some importance of being first, regardless of the type of reactor.

Mr. STRAUSS. The British are no less anxious than we are to see that third nations do not attain an atomic-weapon capability and that, therefore, will have some bearing on their consideration of the sale of reactors of the Calder Hall type without exercising great discrimination as to the purchasers.

Representative PRICE. We certainly hope so. We also note that from the past history of nations, when nations start to scramble for markets, they put aside caution.

The CHAIRMAN. We hope to hear the two other Commissioners this afternoon.

We will recess until 2 o'clock this afternoon.

(Whereupon, at 12:30 p. m., the hearing was recessed, to reconvene at 2 p. m. of the same day.)

AFTERNOON SESSION

The CHAIRMAN. The committee will come to order.

Mr. Cole, do you have any further questions to ask Mr. Strauss?

Representative COLE. I have nothing further.

The CHAIRMAN. I believe Dr. Libby is our next witness.

Dr. LIBBY. Senator Pastore on last Tuesday asked that we consider the proposal of Mr. Murray. I have a statement on that, Mr. Chairman, if it please you, which I will read.

The CHAIRMAN. You may proceed.

Dr. LIBBY. The plan by Commissioner Murray differs relatively little from the announced Commission plan. Mr. Murray wants three different reactors built: an advanced water reactor, a natural uranium heavy water reactor, and a gas-cooled reactor.

Now, as to the first of these, we have several pressurized water reactors now being built in addition to Shippingport. Under construction is the reactor of the Consolidated Edison Co., of which 140,000 kilowatts will be nuclear electricity. At various stages of planning are the 134,000 kilowatt Yankee Atomic Electric Co. reactor and the 20,000 shaft horsepower, merchant-ship reactor.

Now, closely associated to the pressurized water is the boiling water. This is at variance with the pressurized-water pipe as exemplified by the plant of 3,000-kilowatt reactor at Vallecitos, Calif., of the General Electric Co., and the very much larger 180,000-kilowatt reactor of Commonwealth Edison to be built at Dresden, Ill. Both of these are under construction.

Also, in the design and planning stage is the 22,000-kilowatt plant of the Rural Cooperative Power Association at Elk River. A number of such reactors are likely to be sold and built abroad. This we heard this morning from the Chairman's statement.

Now, the second of Mr. Murray's reactors is the natural uranium, heavy-water, moderated reactor. This has been particularly highlighted in the Commission's third-round invitation. It was made clear in that invitation that, if no proposal from industry was forthcoming in a reasonable period of time, the Commission itself would undertake to build this reactor.

Therefore, I think it is apparent that the Commission has indicated its interest in this reactor type. The third-round invitation constituted a policy statement in this respect.

Now, this leaves only the gas-cooled reactor as a point of major difference. Our British friends have undertaken a major program in this field. It seems to the majority of the Commission that we can well rely upon their experience and thus gain something from the very large sums they are spending now on this reactor type.

We have given them so much and have helped them in so many ways, including important help in the gas-cooled reactor itself; why shouldn't we cooperate in this manner?

Therefore, the present Commission policy is to limit its work in this field to small-scale research and development activities. In the planning stage by Aerojet-General Corp. is a gas-cooled reactor experiment to be built at Arco to add to our technology in this area.

Thus, it is clear that in 2 of the 3 cases there is no difference in the objectives and, in the case of the heavy-water, natural-uranium reactor, the only difference is one of timing. It is apparent that in terms of kilowatts of thermal or electric power to be produced, in terms of the size of each project, and in terms of reactor types, the Commission is carrying forward a positive and well-planned program of reactor development.

The Commission is of the opinion that industry should be given a full opportunity to take up the third-round invitation and that the country has everything to gain by allowing industry to do so.

Now, reactors are built by men, and the difficult technical problems which remain to be solved in most of the reactor types require men of outstanding technical ability for their solution. These men are in very short supply and are mainly in the employ of industry and the universities. The question is, as I see it, how can we get them to work on our problems?

The proposal Mr. Murray favors, one of Government ownership entirely, has a potential or possible weakness in it, in that it assumes that the best technical people can be hired away from industry, either directly or through normal contractual arrangement with industry.

Now, I think this is a fallacy, for highly gifted technical manpower is industry's most scarce and valuable asset. On matters of defense and in time of war, industry responds completely. The contributions made by industry in the development of the warlike atom have been indispensable and the country could not have proceeded without them.

However, there is no similar motivation operating on the peaceful use of the atom and when we advertise for bids on the development of these enormously difficult new atomic power types, we cannot expect industry to tell its best people to drop the important jobs they are doing for the development of new processes which pay large dividends and which the industries employing the highly skilled technical people are accustomed to earn.

We cannot expect industry to tell these men to come to work on atomic power projects without some substantial profit return on the contract. This type of contract the Government does not write. The only hope seems to be that industry will see that it itself should undertake, in a partnership arrangement with the Government, a serious attack on the problems of atomic power. This it is now doing.

If it does not continue to assign its technical manpower to the job, then in all probability the job either will not be done or will be delayed by years, for it is true that there exist technical jobs which only the very best men can do, and it is true that reactor types can fail for the lack of the attention of properly skilled men.

The Commission feels every attempt should be made under the American system of industrial initiative to make industry a full partner in the atomic energy program. If this cannot be done, then we stand ready to turn to the next best course which is Government projects.

I feel sure Mr. Murray's proposal is less desirable because it recommends a less desirable course first. The Government incurs a power deficit when it builds its plants on sites where firm power is required and is a necessity, and the experimental power these plants furnish has to be supplemented by firm power purchased from the normal source.

In other words, the power produced in these plants may be valued at little more than dump power. Therefore, a plant which might be built and incorporated, as the Shippingport plant, in a large commercial network with variable power demands, would, if built at Oak Ridge or at Hanford, where firm power is an absolute necessity, create a deficit of many mills per kilowatt-hour. This, over the lifetime of the plant, might amount to as much as the cost of the entire structure.

In other words, the $100 million estimate that Mr. Murray makes for the construction of each of these 3 plants may well have to be doubled in terms of the cost of firmed power before the project is over. Loss of this magnitude is a serious weakness of his plan.

The same plant, if built at a location which would allow its incorporation into a commercial power grid in a partnership arrangement with the power company, might save the taxpayers round $100 million in deficit financing. It is true, of course, that building the plants at laboratory sites and planned sites does avoid the difficulty about the preference clause. However, the Commission so far in its operations under the first and second round has had relatively little difficulty in doing business with both the public and private power groups. It seems likely that this will continue into the third round.

The final point about the Government undertaking directly the development and construction of the full-scale prototype plants is that the Government is not under compulsion to make the economies that private industry as a full partner would be.

Therefore, it is not as likely, it seems to me, that Government construction of a full-scale plant would demonstrate economical atomic power as quickly as would construction under a full partnership of business and Government.

We can expect the economical type of atomic power to be developed first under the compulsion and incentives normal to construction and operation by business.

The CHAIRMAN. Does that complete your statement?

Dr. LIBBY. Yes, sir.

The CHAIRMAN. Then, about the only difference I see, according to your statement here, and Mr. Murray's—is that you have included everything except the gas-cooled-type reactor, dual type like the British are using?

Dr. LIBBY. Yes, sir.

The CHAIRMAN. Referring to the second page of your statement. what do you consider a reasonable period of time? That is the point that has worried me somewhat on this development of reactors.

Dr. LIBBY. You mean under the third-round invitation?

The CHAIRMAN. Yes; under the third round.

Dr. LIBBY. Well, I will have to make my own individual estimate. You realize that our only temporary restriction in the third round is that the plant be completed by June 30, 1962. We have to figure for a type like the heavy water moderated natural uranium reactor where would be a cutoff date so that the plant could be completed by June 30, 1962.

I would estimate that we have a year to go. Now, that may not be a firm or correct estimate, but something of that order. We have come to no firm decision on that.

The CHAIRMAN. Then, in effect, Doctor, you are making the statement that if this reasonable time does not prove sufficiently effective in solving your problems in developing these reactors, you are willing to accept Mr. Murray's statement?

Dr. LIBBY. I should think if we do not receive a proposal that our third-round announcement set, that we would go ahead in a reasonable time. I would think that would mean something like a year, but that, of course, would have to be determined by a careful study, bearing in

mind the one date set in the invitation was June 30, 1962, for production of power, for the completion of the plant.

The CHAIRMAN. You also referred to what you can get in the way of information on gas-cooled dual-type reactors from the British since they are building this type. Can you elaborate on that to the extent as to how much information?

Dr. LIBBY. We have a provision in our bilateral that says when either party indicates a serious interest in a reactor which the other one is building, we have permission for transfer of information.

Representative PRICE. May I ask a question there? Is that not contingent upon your being engaged in such a project.

Dr. LIBBY. Yes, sir. It depends on our declaring that we are ready to go ahead on such a project.

Representative PRICE. If you are not going ahead with a gas-cooled project, how are you going to get the information?

Dr. LIBBY. If their experience looks good, Mr. Price, we want to build one. We can call on their know-how at that time.

Representative PRICE. You would have to start from scratch and build one then?

Dr. LIBBY. Yes.

Representative PRICE. In order to get the information you have to actually be conducting that type of project.

Dr. LIBBY. That is our present wording of the treaty.

Senator ANDERSON. You have to be building one before you ask them for any information on how to build it?

Dr. LIBBY. Yes; but in this day of declassification of atomic power, I don't think there would be any difficulty about getting enough information to know whether their reactor is a success.

The CHAIRMAN. How long has the bilateral agreement been in effect, Doctor? I do not recall the date.

Mr. FIELDS. I believe it is in the summer of 1955, sir.

The CHAIRMAN. Do you feel that, since having that experience, you are getting all the information that is necessary to build a gas-cooled-type reactor? Do you feel that you are getting all the information necessary from the British at the present time?

Representative PRICE. Is it not a fact that you are getting no important information at all on the gas-cooled reactor?

Dr. LIBBY. The information we are getting from the British is not very special or detailed, as I understand it, at this time.

Senator ANDERSON. Is that responsive to his question? He asked, Are you getting anything at all from the British on their gas-cooled reactor? Since the agreements in 1955 have we had any information from them?

Dr. LIBBY. We have had visits back and forth, but I don't believe the amount we have gotten is anything much more than is in the general newspapers.

You see, there is quite a revolution in atomic power, I think we will all recognize, in the declassification of it that is going on. Now, I do believe that, just as in the case of our Shippingport plant, there will be enough information available to everyone about the Calder Hall types so that we will be able to come to a good opinion about the practicality of it and then, as I understand the wording of our bilateral, when we choose to proceed to build such a plant, the terms of

the bilateral will allow us to get from them any classified information they have not disclosed.

Representative PRICE. You can probably buy one at that time from the British.

The CHAIRMAN. The reason I raise the question, Doctor, is because you say in your statement you will get a good deal of information from them which will be helpful to us in arriving at a conclusion whether or not it will be worthwhile. Of course, if we are not getting any information, it is not very helpful. I do not see where that is going to be very much help to us.

Dr. LIBBY. I think we are getting information but we are not getting more than other countries. We are not getting much more than the general public is getting.

The CHAIRMAN. I will put it like this: Are we getting any more information than what we already know at the present time on gas-cooled-type reactors?

Dr. LIBBY. I do not know in detail, Mr. Durham. I would like to ask the General Manager to give a more definite answer to your question.

Senator ANDERSON. Could we ask it this way? Have you asked for any more than you are now getting out of the newspapers? You said we are getting nothing that is not in the newspapers.

Dr. LIBBY. That was my impression: That the amount we get over and above what is generally known is not very substantial, but I would like to ask the General Manager to correct me, if I am incorrect.

Mr. FIELDS. As I understand, we have the information that they have relayed and have had conferences on this reactor. We are not getting the detailed information that it would take to design reactors.

Senator ANDERSON. Would you say you are getting nothing that has not been published already in the newspapers?

Mr. FIELDS. I could not answer that. I imagine it is that, sir.

Senator ANDERSON. Now, have you asked for anything else? We have asked for something else and we have not obtained it?

Mr. DAVIS. That is correct.

Mr. FIELDS. The British are not under any obligation, according to the bilateral.

Dr. LIBBY. In addition to the paragraph of the bilateral which I mentioned, which mentioned that in case we undertake to build a gas-cooled reactor, we do have a right, there is another paragraph which is in article I, section (c) (iv), which says:

> Restricted data on specific experimental power, demonstration power, or power reactors will not be exchanged unless the reactor is currently in operation in the receiving country or is being considered seriously for construction by the receiving country as a source of power or as an intermediate step in the power-production program.
>
> There shall, however, be exchanged such general information, including restricted data, on design and characteristics of various types of reactors as is required to permit evaluation and comparison of their potential use in a power-production program.

That is a little stronger than as I described it to you.

Senator ANDERSON. Could I pick up there and call attention to the statement that you say:

> In the planning stage by Aerojet Corp. is a gas-cooled reactor experiment to be built at Arco.

Now, why, under those circumstances have they declined to give us any information on the gas-cooled reactor which Mr. Davis says they have declined to give them?

Dr. LIBBY. I am not of the opinion that they have declined to give it.

Senator ANDERSON. They have given us what is in the newspapers. You would not regard that as giving us anything, would you? If we can find anything in the press, they will be glad to communicate that much to us? If we cannot find it in the press, it is not available to us?

Dr. LIBBY. I think probably, Senator Anderson, the point is that they have not gotten as far along as many of us might have supposed and the amount of information that they have that is additional and valuable and critical as of the present time——

Senator ANDERSON. It is running; is it not?

Dr. LIBBY. It is running.

Senator ANDERSON. Mr. Davis says we have wanted additional material. Now, if we have wanted it and we have this one planned, do you not think the bilateral should let us get it?

Dr. LIBBY. I think we will get it when they have it.

Senator ANDERSON. Yes; when it is available in the newspapers.

Representative COLE. I wish we could find out what we have asked from the British that they have declined to give to us. Mr. Davis nodded his head that we have asked for something. I would like to know what we have asked for that they have refused to give.

Mr. STRAUSS. My understanding, Mr. Cole, is that we have asked for certain information which we have not yet received but there has been no refusal to give it. I assume on the basis of the fact that I expect them to carry out their obligation that they are either in the course of compiling it or that they do not have the answer to the questions that we have asked.

Our people, however, have visited the plant on several occasions and there have been no attempt to conceal any part of its operation or structure.

Representative COLE. There has been no refusal?

Mr. STRAUSS. No refusal. So I think the record might be improved by indicating that there has been no refusal.

The CHAIRMAN. Mr. Van Zandt?

Representative VAN ZANDT. Admiral, I was impressed by the Whaley-Eaton Service letter, released February 8, 1957, regarding Britain's atomic power program. Does the Commission have this letter in its files?

Mr. STRAUSS. How do you identify it?

Representative VAN ZANDT. It furnishes a lot of details as to the cost of kilowatt construction and so forth.

Mr. STRAUSS. Yes, Mr. Van Zandt.

Representative VAN ZANDT. Isn't that about the level of information that we have to date?

Mr. STRAUSS. I could not say because I have never before seen the letter to which you refer.

Mr. DAVIS. It has been some time since I have looked it over. Actually we have gotten, and the British have released publicly, quite a bit of information about the Calder Hall reactor and about the proposed CEA power reactor.

There are a considerable number of technical features in details, things that go back to technology, which we have not received and

which, of course, we would like to get. It may not be exchangeable. In any case we have not been able to get it.

I think I should point out in connection with the gas-cooled reactor experiment at Idaho, however, that this is really quite a different kind of reactor. This is intended to be a small reactor operating with highly enriched material and operating at high temperatures and driving a closed cycle gas turbine. It is quite different in concept from the British reactors which are more modest, although still fairly high temperature, which operate with natural uranium with graphite moderation and use the heat to generate steam.

There are really quite substantial differences. I do not know if we can really say that this is precisely the same kind of thing and, therefore, is exchangeable under the terms of this bilateral agreement.

Representative VAN ZANDT. Could you tell the committee what it costs the British Government to produce 1 kilowatt-hour of electric energy in their gas-cooled reactor?

Mr. DAVIS. It would be very hard to say what the cost is today because first of all, even the Calder Hall reactors are not operating at full power nor at full temperature. I think if one went back and tried to make an estimate right now, you would find the costs are indeed extremely high because they are operating under quite rigorous conditions still.

Representative VAN ZANDT. Is it 30 or 40 mills?

Mr. DAVIS. I hazarded a guess at one time which I think is probably not far from wrong, that if we were to build a Calder Hall reactor at the same cost it cost them to build one and if it were operated in this country our financing, the cost would be about 20 mills per kilowatt-hour. If this is extended to the large CA reactors which will not be in operation until 1960 or 1961, these costs become something more like 15 or 16 mills, assuming it is built in this country and operated under our type of financing.

If built in England and operating under their financing, the costs will be different.

Representative VAN ZANDT. Mr. Chairman, could we make this letter a part of the record, because it contains a lot of information that I think is very valuable to the committee.

The CHAIRMAN. Without objection, it will be inserted.

(The Whaley-Eaton Service letter follows:)

BRITAIN'S ATOMIC POWER PROGRAM

(The Gas-Cooled, Natural Uranium Reactor)

LONDON, *February 8, 1957.*

DEAR SIR: British scientists seem certain they can develop a practical method of recycling the byproduct plutonium as an economic fuel. If this proves true, Britain may be able to slash proposed future imports of uranium. The following reports on this situation:

Plutonium has more different isotopes and a wider variety of properties than is commonly realized. Uranium-238, when bombarded by neutrons in a reactor, is transformed into plutonium-239. Sixty-five percent of the plutonium formed itself undergoes fission, but the remainder captures a neutron without fissioning and is transformed into a nonfissile isotope, plutonium-240. By absorbing a

neutron, Pu240 is transformed into a new fissile isotope, Pu241. This is a useful isotope, because it is even more fissile than Pu239. In fact, 80 percent of Pu241 undergoes fission, the remainder being transformed by neutron capture into Pu242. This is, for all practical purposes, the end of the chain.

Pu242 is nonfissile, and gradually accumulates in a reactor. If fuel is constantly recycled, plutonium being extracted, mixed with fresh fuel and put back in a reactor, the proportion of nonfissile Pu242 will increase with a consequent loss of reactivity.

PLUTONIUM RECYCLING

There are two possible ways of getting round this difficulty: The first is to build a gaseous diffusion plant to extract Pu242 and leave the fissionable isotopes. The other way is simply to throw the depleted fuel away as soon as the concentration of Pu242 reaches an uneconomic level. To work out the best way of recycling plutonium so that the maximum proportion undergoes fission, and to calculate the moment to throw the remainder away, is the crux of the problem. There is still no clear answer, but British scientists at Harwell are working on what they consider to be a very promising line of approach.

They propose that after the initial charge of natural uranium fuel has been irradiated for some time, it should be changed, and the plutonium extracted. This would then be alloyed direct with magnesium, aluminum, or zirconium and machined into a new kind of fuel element, containing no uranium at all. It could then be inserted direct into the reactor, which would also contain either fresh natural uranium fuel elements, or depleted uranium. Either way, by keeping the plutonium separate from the uranium, it can be removed at exactly the right moment, i. e., before the nonfissile Pu242 begins to accumulate appreciably—without discharging the whole reactor, as would be necessary if the plutonium were blended with uranium.

On this basis, the Harwell scientists believe a highly economic fuel cycle for natural uranium fueled reactors involving high "burn up" can be developed.[1]

CUTTING URANIUM IMPORTS

All this clearly has a bearing on the hotly debated question of how much credit it is legitimate to allow for plutonium produced in a Calder Hall type power station when calculating the cost of the resulting power. If processing costs per gram of plutonium burnt can be sufficiently reduced, plutonium becomes a relatively more useful fuel to recycle and a correspondingly higher credit can be claimed for its production.

In any case, whatever the credit allowed, efficient processing and recycling means higher "burn up" and lower operating costs. At present it looks as though recycling could mean that instead of importing, say, 1,000 tons of uranium a year to replenish the Calder Hall type reactors, it would only be necessary to import 10 tons.

COMPETITIVE A-POWER

Most British scientists and engineers now believe that natural uranium gas-cooled reactors will be easily competitive with conventional stations in a year or two without allowing any credit for plutonium. (Efficient recycling will simply have the effect of making them more economic still.)

This will happen, it is expected, partly because the improved nuclear stations will show big increases in electrical output for only moderate increases in capital cost, and partly because the price of coal will rise. Coal is being held at an artificially low level at the moment, and recent calculations indicate that the capital investment which might be required to raise coal production and to build conventional stations to burn the coal would not be widely different from the investment required for an equivalent atomic program.

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[1] The prospect of using plutonium in fast or homogeneous enriched reactors is a different question, outside the scope of this report It is held that this will not materially affect the British program for at least 15 years.

COAL VERSUS ATOM

Actual comparisons, based on the best presently available estimates from authoritative sources, are shown in the table below:

Conventional coal-fired power stations:	
Capital cost per kilowatt of installed capacity	$168–$182
Additional investment to get extra coal (per kilowatt, base load)	140– 150
Additional investment needed in ancillary plant, rail sidings, and rolling stock, port facilities	56– 84
Total	364– 416
Nuclear powerplants:	
Capital cost per kilowatt of installed capacity (This relates to the first 3 Central Electricity Authority stations. Later plants should be lower.[1])	308– 336
Fuel charge per kilowatt of installed capacity	84– 98
Cost of mining, concentrating ores; fabricating, reprocessing fuel elements, etc., per kilowatt installed capacity	28– 42
Total	420– 476

[1] The Central Electricity Authority stations which follow the first 3 will probably have capital costs of $364 to $420, about the same as those of current conventional plants.

OTHER FACTORS IN THE COMPARISON

A brief table cannot tell the entire story. There are other factors, too. Investment needed to win additional coal for new conventional plants will increase with the depletion of more easily exploitable seams. While the supply of both coal and oil are subject to some uncertainty, this does not apply to fuel for reactors.

The overall cost of an oil-fired conventional plant is estimated at $360 per kilowatt of installed capacity, including investment in the production of additional oil, its transportation, storage, etc. The capital costs of nuclear plants, unlike those of conventional stations, are more likely to decrease than increase in the coming years.

In view of the closeness of the figures at present and of the likely future trend, there is considerable conjecture that the conservative Central Electricity Authority may be called upon to modify its present views. In face of all the factors outlined above, CEA still maintains that it would not be wise to acquire so many atomic stations which, to be economic, must operate at base load; that during off-peak periods CEA might have exceedingly expensive plants merely "ticking over." But other authorities see this as a timorous attitude, since rate concessions and other advantages can encourage consumption at other than peak periods.

Recent events in the Middle East seem likely to encourage the less conservative view.

Very truly yours.

WHALEY-EATON SERVICE.

The CHAIRMAN. Dr. Davis, can you furnish the information to the committee that was requested from the British and the date it was requested? If it is confidential, we will treat it as such.

Mr. DAVIS. Yes, sir.

(The information referred to follows:)

UNITED STATES ATOMIC ENERGY COMMISSION,
Washington, D. C., March 8, 1957.

HON. CARL T. DURHAM,
Chairman, Joint Committee on Atomic Energy,
Congress of the United States.

DEAR MR. DURHAM: Reference is made to the questions raised during the recent section 202 hearings concerning exchanges of information with the United Kingdom on civilian reactors, and particularly on gas-cooled graphite moderated nuclear power stations. From the colloquies which took place, it appeared that some members of the Joint Committee were under the impression that the British authorities had "refused" to furnish us information requested under the

existing bilateral agreement for cooperation. Although the matter of a detailed exchange relating to gas-cooled graphite moderated reactors under article II–A–2 of the agreement has not yet been fully resolved, the Commission considers it important to present the matter to the Joint Committee at this time in order that the problems involved may be thoroughly understood.

Since the effective date of the bilateral agreement in July 1955 the reciprocal exchange of information between the United Kingdom and the United States has been useful to both countries and has covered many subjects, including the Calder Hall gas-cooled graphite moderated reactor. The exchanges of information which have taken place have included the transmittal of reports, and visits and discussions by representatives of both countries.

As might be expected, the volume of information exchanged to date has been under article II–A–1 of the agreement. Specific information is now being exchanged under this article on the following reactor types:

Research and test reactors.
Pressurized water reactors.
Boiling water reactors.
Homogeneous reactors.
Fast breeder reactors.
Sodium graphite reactors.
Liquid metal fueled reactors.
Gas-cooled reactors.

The United States has benefited notably from information received under article II–A–1 exchanges relating to fast reactors, homogeneous reactors, and the general subject of reactor hazards pertaining to all types. Since the agreement to exchange information on gas-cooled reactors under this article dates back only to November 8, 1956, it is still too early to evaluate the results, but we have every reason to believe that the exchange will be profitable to the United States.

At the present time, detailed, technological information on power reactors under article II–A–2 of the bilateral is being exchanged only in connection with experimental fast-breeder reactors. This exchange began in February 1955 and under it the United States has obtained applied technology on the British Zeus, Zephyr, and Dounreay reactors. Cooperation under this program has been of the highest order. Except as discussed below, the United States has made no other requests for an exchange of reactor information under article II–A–2.

With specific reference to gas-cooled reactors, the first approach to the United Kingdom for an exchange of information was made orally in January 1956 but was put in terms of obtaining sufficient Calder Hall information to permit a realistic evaluation of its usefulness in the Commission's program. The British advised that this was not possible under article I–C (iv) of the agreement for cooperation which establishes the condition that the type of reactor involved "is being considered seriously for construction by the receiving country."

The matter of a detailed exchange under article II–A–2 was raised in September 1956 during a visit to the United States by Sir John Cockcroft and Mr. William Strath, members of the United Kingdom Atomic Energy Authority, without resolution but with reservations on the part of the British based on indications that important segments of the information desired by the United States were commercially owned. In this connection, it should be noted that under article I–D of the bilateral it is recognized that the agreement "shall not require the exchange of any information which the parties are not permitted to communicate because the information is privately developed and privately owned * * *," and that any exchange under article II–A–2 must be pursuant to specific agreement between the two countries.

By letter dated November 8, 1956, the United Kingdom agreed to an exchange under article II–A–1 with a United States technical team which visited England in November and December 1956 for classified discussions on gas-cooled reactors. In addition, during the past 12 months some 51 United States experts have inspected Calder Hall reactors and many of these had, in addition, technical discussions at Risley and Harwell with senior United Kingdom scientists and engineers. Further, the United Kingdom Atomic Energy Authority has advised that they are now compiling information to be transmitted under article II–A–1 on the "overall design and characteristics and operational techniques and performance of the nuclear power stations which have been ordered by the Electricity Authority."

On January 24, 1957, the Commission formally requested that the United Kingdom Authority agree to an exchange of information on gas-cooled reactors under article II–A–2 of the bilateral. In this request, it was specifically proposed "that we agree to a continuing exchange of classified and unclassified information relating to detailed designs, detailed drawings and applied technology of gas-cooled reactors and of related components, equipment, and devices * * *. The information to be exchanged under this agreement would include, of course, information from the sources specified in article II–A–3."

This matter was subsequently discussed in detail with Mr. David E. H. Peirson, Secretary, United Kingdom Atomic Energy Authority, in a series of meetings in Washington on January 30 and 31, 1957. Mr. Peirson at that time outlined the problems presented by industrial ownership of much of the information sought and the conflicting policies of the United States and United Kingdom Governments in the matter of disseminating Government-owned information. These are discussed below in this letter.

Since the problems outlined by Mr. Peirson, and subsequently reiterated by Sir Edwin Plowden, Chairman, UKAEA, would not apply to the Calder Hall reactor (as distinguished from information developed by private United Kingdom industry for the CEA reactors), the Commission on March 1, 1957, requested immediate agreement on an exchange of information under article II–A–2 limited to the Calder Hall reactor "pending further discussion and consideration of the broader problems * * *."

In response, Sir Edwin, by cable dated March 4, 1957, agreed in principle to an exchange on the Calder Hall reactor under article II–A–2. In agreeing to such an exchange, however, the United Kingdom proposed that an order to achieve the reciprocal basis of exchange contemplated under article II–A–3, there should be a similar exchange on the Shippingport PWR. In addition, for reasons explained later, the United Kingdom has requested that gas-cooled reactor information exchanged under the proposed agreement be made available in the United States only to the Automic Energy Commission and its contractors actually working on a gas-cooled graphite moderated project, with the understanding that any information received by the United Kingdom would be similarly confined. Further discussions with the United Kingdom will be held on these points.

An important point in the British position, and one which applies equally to exchanges under article II–A–1 or article II–A–2, is related to the fundamental differences of policy which exist in the United Kingdom and in the United States with respect to the dissemination of Government-owned information. The United Kingdom's position in this regard is clearly set forth in the Second Annual Report of the United Kingdom Atomic Energy Authority (1955–56) to Parliament, paragraphs 168 through 170. In essence, in the United Kingdom it is Government policy to require private industry to pay a royalty for any commercially valuable information made available by the Government—as a contribution toward the cost that the British taxpayer has incurred in financing the research and development work involved. This policy applies not only in the atomic-energy field but to any information developed by the British Government which has a commercial application. The matter of the jet engine has been cited as a good example of the operation of the policy in other fields.

Accordingly, the Authority has established, parallel to its security classification system, a commercial review and marketing system. Documents, whether classified or unclassified, are marked (*a*) "Commercial" if they contain information on gas-cooled reactors, and (*b*) "Official Use Only" (semicommercial), if they contain information of minor commercial significance.

"Commercial" information is made available to British firms only on commercial terms; for example, information on the Calder Hall reactors was made available to the industrial groups which have designed the CEA reactors only under a license which provided for the payment of royalties. "Official use only" information has been made available to British private companies under access agreements with the AEA which call for the payment of a royalty if and when commercial use is made of the information.

The basic difference inherent in this United Kingdom policy and the policy of the United States to disseminate Government-owned information without charge is apparent. The United Kingdom authorities, accordingly, have argued that, if United Kingdom information were to be made freely available to American industry under the access permit programs, this would completely undermine the grounds on which the Authority has required British industry to pay royalties for commercially valuable information, have serious repercussions in other

fields, and create the anomalous situation whereby United States firms would be given British information without cost while United Kingdom firms would be charged a fee for the same information.

Thus, there emerge three basic issues which require further discussion with the British:

(*a*) Whether information received from the United Kingdom under either article II–A–1 or article II–A–2 of the bilateral can be distributed to AEC access permit holders. In this connection it is noted that a difference may exist with respect to article II–A–2 information, since any exchange under this article is subject to specific agreement and presumably the party transmitting the information could condition or limit its use.

(*b*) Whether information concerning the reactors designed by private firms in the United Kingdom for the Electricity Authority is exchangeable under the bilateral, or whether such information is subject to the limitations expressed in article I–D.

(*c*) Whether article II–A–3 requires a balancing reciprocal exchange as a condition in each instance to agreement under article II–A–2. This is pertinent to the United Kingdom request for information on the Shippingport reactor.

I am confident that the Joint Committee will understand that these issues, involving as they do basic Government policies and difficult questions of interpretation, are not easily or rapidly resolved by either party. In the meantime, the United States is receiving from the United Kingdom information on gas-cooled reactors under article I–A–1 of the agreement for cooperation and has obtained an offer from the United Kingdom to enter into an article II–A–2 arrangement. Both types of exchange should prove helpful to the Commission in evaluating the usefulness of gas-cooled reactors in the United States program.

We will, of course, advise the Joint Committee of the resolution of the issues presented herein as soon as we have reached mutual agreement with the United Kingdom Atomic Energy Authority.

Sincerely yours,

LEWIS L. STRAUSS, *Chairman.*

Representative HOLIFIELD. Mr. Libby, I want to discuss with you briefly, the philosophy which you enunciated on pages 3 and 4. As I understand it you bring up the fact that technical men, men of outstanding technical ability are few, that they are mostly in the employ of industry and universities and the problem is, how can we get them to work on our project.

You say that you feel that the proposal that Mr. Murray favors has a weakness in it, in that it assumes that the best technical people can be hired away from industry, directly or through normal contractual arrangement with industry.

You go on to say that you think that is a fallacy. You further state you cannot expect industry to tell its best people to drop the important jobs they are doing for the development of new processes which pay large dividends which industries employing highly technical people are accustomed to earn.

You say we cannot expect industry to tell these men to come to work on atomic power projects without some substantial profit return on the contract.

Now, I would like to explore with you this philosophy. Do you honestly and sincerely believe that if the Government would announce that they were willing to embark and finance on full-scale gas-cooled reactors, which might run between $75 million and $100 million, if they had the funds to do this job, do you honestly believe there would be a scarcity of industrial firms that would want to come in and bid on that contract to build it for the Government?

Dr. LIBBY. No, Mr. Holifield, I do not believe that. What I meant to say was that these firms would not necessarily put their most valuable people on a cost-plus type contract.

Representative HOLIFIELD. Let us explore that. Do you feel that the Westinghouse people, in bidding on the Shippingport contract and coming into this job, have assigned less than their first-class men on their work?

Dr. LIBBY. I think they have put some very good men on the job and they have hired some men, too.

Representative HOLIFIELD. As a matter of fact, it is not really a question of the Government taking away from industry these high-class technical men. It really comes down to the point of letting the men stay with the companies that they are now employed with and providing those companies with a project which they do not as yet have, as I see it.

For instance, I think, if we wanted to build a gas-cooled reactor of the type mentioned, I am sure that the machinery-manufacturing people would be just as interested in building it for the Government as they would in building it for the utilities, because it would be a large-scale effort and it would be in a new and advanced field and it would seem to me that, as we have had no trouble in the past getting these companies to come in, even in peacetime, and work on these projects after the war. We have so many people bidding on anything that is put up to be made, to be built by the Commission, it seems to me that you are the one that is building a fallacy here.

It seems to me that, instead of not having cooperation from industry, you would get that cooperation from industry because I would visualize the Government doing a job like this by contract just like they did the Shippingport job.

Dr. LIBBY. Mr. Holifield, we have two kinds of job in peacetime. We have the continuing production of atomic weapons and this kind of job. We have had the very best service from companies like Du Pont and General Electric and so on in these plants where they are definitely taking part in the defense effort.

But there is a big difference between that kind of operation, which they undertake for patriotic reasons—they certainly don't do it for profit reasons—and the kind of program we are talking about in the development of atomic power.

Representative HOLIFIELD. I cannot see that, because it seems to me that, in those projects which have been along the line of peacetime application, you have not been wanting in people to enter those fields.

Representative PRICE. Will the gentleman yield there?

Representative HOLIFIELD. Yes.

Representative PRICE. I think your problem would be more simple in this type than it would be on the Du Pont or General Electric permanent operation of a facility, because this would be a construction program and a construction contract for these companies. I think it probably would be less difficult.

Dr. LIBBY. Gentlemen, it is certainly a matter of opinion and judgment. I do not agree with you. I think that the way to get these people, and, believe me, I am right, I think, in saying that for certain kinds of industry their highly skilled, technically skilled manpower is their biggest asset. These people are very precious. They have lots of people they can put on any given job they take up, but they do not have so many of these key fellows who can solve these very critical problems which stand between us and economic atomic power.

Now, being a technical man, I may be overemphasizing this, but I look around and try to see whom I would get to undertake a solution of a particular program and I know these men and I doubt very much, without any patriotic motivation, if we could get a company to assign those men.

There may be only a half dozen in a given company and you may not know them from the hundreds of others, but there may be only a half dozen that make all the difference. It would be very difficult to get those men to work on these jobs.

Of course, Mr. Holifield, if this thing does not work, we are going to try the other one. I hope to goodness that you are completely right.

Representative HOLIFIELD. Has not all our progress been made just under this manner of operation, with the Commission directing and controlling, you might say, the design and ultimate purpose and the objective, but subcontracting or rather contracting with private industry to do the job.

It seems to me that the weakness in your philosophical statement here is based on the statement that we are hiring away from industry these technical men, when my position is that the Government would not be hiring them away from industry, but would be hiring industry to use them in this type of a tremendously challenging project.

I just cannot believe that private industry, with its desire to get into this field, as is shown by its attempt to devise these different arrangements to participate in a partnership program, I just cannot believe that there is no competitive feeling among the manufacturers of equipment that would make them jump at the chance to get this experience, this advance technique and know-how with the money to do the job of experimentation.

Certainly, their primary interest is in learning this business and in getting the experience which you can only get by building a large reactor. I would venture to say if you would offer this type of contract to American industry that you would have a number of offers from reputable people like Westinghouse and GE and Du Pont and others who would be glad to get into this field and get into it from the standpoint of increasing their own experience and becoming competitive in the international race. I am afraid they are not going to be able to become competitive at the rate we are going.

Dr. LIBBY. You do get my distinction, Mr. Holifield? I am sure they will come in with a bid. What I am worried about is the small number of their top engineers and scientists, whether they will put those men onto these jobs. That is what I am worried about.

Representative HOLIFIELD. That would be part of your responsibility for expenditure of Government funds, to see that they were bona fide bidders and put their best effort into it. I am just thinking you are making your deductions and your conclusions on a philosophy which you have not tested as yet in this field.

Dr. LIBBY. It is true that I have not tested it in this field, Mr. Holifield, but there is a great deal of similar experience in other development programs which clearly proves——

Representative HOLIFIELD. You have just told us in your testimony before this committee how you have already solved it by turning over to industry the fabrication of fuel elements. They were glad to come

in and do it at a contract price. You did fall down on the processing project and you have not yet been able to get a company to come in on the processing, it is true, because they can see no profit incentive in that.

But, certainly, with the desire to build these reactors all over the world, any first-class big corporation that is interested in building machinery would be interested in coming in on a proposition like this, it seems to me.

I must reject your reasoning here. I just do not believe that it holds water. I am not talking about heavy water, either.

The CHAIRMAN. Dr. Libby, before we get away from this gas-cooled type reactor, in reading one of the statements filed here by the Ford Instrument Co., can you give us the reason why the Commission turned down the proposal by the Ford Instrument Co.?

Dr. LIBBY. You mean the city of Holyoke?

The CHAIRMAN. Yes.

Dr. LIBBY. I will have to ask Mr. Davis to give those reasons.

Mr. DAVIS. This is the one which would be much more similar to the type that we are just starting development on with Aerojet. In other words, a compact, small, highly enriched fuel cycle gas turbine reactor.

In our exploration into this, we can see that there are very many difficult problems. It is our feeling that, to try to tie ourselves down at this time to the construction of a plant, we are just dealing with something that has a very uncertain future.

The CHAIRMAN. I thought it was the intent of Congress and your proposals, and the way you have been operating, to try in every way possible to do more research and development in most any field of reactors, most any type.

Mr. DAVIS. We are carrying forward research and development on this type of reactor. The difficulty is that we do not have a base today, even in exploratory type of research and development, to try to assess what needs to be done.

One of the problems is that we do not know whether we can build fuel elements that will contain the fission products. At these high temperatures they are probably going to leak out of the fuel element regardless of what we do. One then has gas which is quite highly radioactive. Another problem is that of seals which have not been developed.

It looks like a long-term proposition and a difficult one, one on which we have some work underway, but we feel we have to go through the exploratory stages before we start talking about building a plant.

The CHAIRMAN. Do you know whether any other proposals for a gas-cooled type reactor have been turned down or accepted by you?

Mr. DAVIS. Not that I know of.

The CHAIRMAN. This is the only one?

Mr. DAVIS. Yes.

The CHAIRMAN. It is a very responsible company and, of course, it did a lot of work for the subsidiary Sperry Corp. I imagine they have done a lot of work on reactors. That is why it struck me as peculiar that the proposal was turned down.

Mr. DAVIS. They have done some work on things like control systems, but I do not believe on reactor systems as a whole.

The CHAIRMAN. They are willing to spend their own money. That is what impressed me.

Mr. DAVIS. They are willing to spend some of their own money, but the research and development would have been largely at our expense.

Senator ANDERSON. Can I ask a question on that? I understand that when you turned down the Ford Instrument Co. and the city of Holyoke, that you went to Aerojet.

Mr. DAVIS. We already had that work underway.

Senator ANDERSON. Was Aerojet already busy with other Government contracts?

Mr. DAVIS. They have a large number of Government contracts.

Senator ANDERSON. Air Corps guided missiles and everything under the sun. They were not short of this manpower at all, were they?

Mr. DAVIS. They have some manpower, yes.

Senator ANDERSON. Dr. Libby, on page 4 you say,

> We cannot expect industry to tell these men to come to work on atomic power projects without some substantial profit return on the contract.

Can you tell me how much profit there was for Westinghouse on the Shippingport contract?

Dr. LIBBY. I don't know it exactly.

Mr. STRAUSS. They contributed their profit to the cost of the project, Senator.

Senator ANDERSON. So there was no substantial profit return on the contract?

Dr. LIBBY. They have done very well by us.

Senator ANDERSON. How do these things jibe now?

> We cannot expect industry to tell these men to come to work on atomic power projects without substantial profit return on the contract.

The Shippingport contract has gone up very materially. It was suggested this morning that it would be the Government's part of it, but is it because Duquesne did not put the good work into this?

Dr. LIBBY. I would not say that.

Senator ANDERSON. There was no profit return on the contract. There was no substantial profit return on the contract. Do you think that Westinghouse and Duquesne have done a good job on it?

Dr. LIBBY. I think they have done a pretty good job.

Senator ANDERSON. How about the Argonne? Is there any substantial profit return on the contract at the Argonne?

Dr. LIBBY. None at all. Well, the university gets some return for management overhead.

Senator ANDERSON. Do you think they are getting a good job?

Dr. LIBBY. I think the Argonne is doing a very good job.

Senator ANDERSON. In my hometown, Western Electric has a contract to work at Sandia Corporation. I understand there is no profit on it at all.

Mr. FIELDS. That is correct.

Senator ANDERSON. We had Mr. Quarles out there for a while.

Dr. LIBBY. That, Senator, falls in my other category of a defense type contract.

Senator ANDERSON. Then, do I understand that you think these companies will only operate for the public good when there is a chance to kill somebody, but not if there is a chance to help somebody?

Dr. LIBBY. No. As I said the patriotic motivation is a very, very strong one.

Senator ANDERSON. You do not think that peace is just as patriotic as war?

Dr. LIBBY. I believe that a company feels less compulsion to take its top personnel which, as I say, in many businesses is its prime asset and assign them to a peacetime project where there is little profit opportunity.

Senator ANDERSON. Would that be regarded then, as an indication that you do not think the atoms-for-peace program can work?

Dr. LIBBY. No, sir; I think it can. I think it is working.

Senator ANDERSON. You are not going to get these top people on the atoms for peace?

Dr. LIBBY. We are getting a lot of people through this partnership arrangement.

Senator ANDERSON. Which partnership? Did you regard Shippingport as a good partnership arrangement?

Dr. LIBBY. I think Shippingport has done very well, yes. But I would like to have us try to get our heavy water moderated reactor built with the same kind of partnership arrangement. If we cannot we will do it the other way.

Senator ANDERSON. If you ask for it and in comes the city of Holyoke and this company you referred to, they will get turned down. This Ford Instrument Co. got turned down. They had a good reputation and are part of Sperry Gyroscope, which I understand is well regarded all over the country. Did they not just join Remington Rand which has General MacArthur with it?

Dr. LIBBY. Well, it is a matter of judgment. This is my judgment on it, Senator: That is the prime consideration of Dr. Zinn, or the fellow who is going to take hold of a reactor concept and do it, and this is the thing that is of prime consideration.

I want to have more fellows like him in on this job. I think we have a somewhat better chance by the method that we are proposing than by Mr. Murray's method, though I think we may very well succeed by the Government method if we have to.

Senator ANDERSON. We had Dr. Zinn when it was a Government program exclusively?

Dr. LIBBY. That is right.

Senator ANDERSON. Then, the only hope to get the people is when we have a Government program exclusively?

Dr. LIBBY. We hope to get more of them. We have certain aspects of our job which Mr. Holifield just mentioned, the chemical processing. Of course, it is naturally later in the picture than some of the other phrases of the job, but that is a big task and I hope to goodness we are going to find that the chemical companies step forward and take hold of that job with real enthusiasm.

Senator ANDERSON. I know, Dr. Libby, that you are as anxious to have the program go forward as I am. I want to put that someplace in the remarks. I want to call attention to the fact that when we were having a hearing on accelerating the reactor program last year, the same sort of statement was made, that you cannot get people.

So, on page 524 of the hearings you will see that I sent a telegram to 42 companies saying that,

In connection with consideration by Joint Committee for proposals for acceleration of civilian reactor program, the following information would be appreciated: (1) Does your company have any experience in the atomic energy program? (2) If the Government undertook to design and construct one or more additional prototype reactor projects, is your firm qualified to assume full or partial responsibility for carrying on such a project under prime contract or subcontract? If partial responsibility, please indicate what part of a reactor project you could undertake. (3) Do you know of any other firms which might make a contribution to a reactor project?

From page 524 on through for several pages such names as ACF Industries, Allis-Chalmers, American Standard, the Bechtel Corp.—I believe Steve Bechtel told me on my way up to see this new General Electric plant that they had some 1,800 engineers working for them—Bendix Aviation, Blaw-Knox, they all thought they could do something.

Dr. LIBBY. Yes, that was an impressive return on your telegram. I think you can get the companies to come in and take contracts of this type, but what I am worried about is their putting their best men on these contracts when they have other requirements in this normal business.

This is particularly true of certain types of industry where the supply of the top grade technical people is scarce relative to the demand. I think our chance will be better if they are full partners in the deal. That is my principal reason.

Representative HOLIFIELD. You mean by that, that you think your chance would be better if these companies have to put up their own money?

Dr. LIBBY. To a certain extent.

Representative HOLIFIELD. And lose in an uneconomic venture?

Dr. LIBBY. If they have their own money and their own representation at stake, together with the Government, I think the chance will be better. That does not mean we cannot succeed by the other arrangement if we have to, but I think this is a better approach.

Senator ANDERSON. May I return to Aerojet for just a moment?

When we questioned Mr. Davis we pointed out that the project that was proposed by the Ford Instrument Co. in the city of Holyoke was somewhat different than what the British were doing or what we were planning. Isn't what Aerojet is doing somewhat different? Aerojet is in a military contract, is it not? It is listed as military prototype and experiment on page 358 of the 21st semiannual report of the Atomic Energy Commission.

Mr. DAVIS. Senator, the situation there is that we have had this as more or less of a joint project between our civilian power reactors branch and the Army reactors branch. This seemed to be something for which they had a more immediate requirement for a useful plant and we, therefore, assigned the responsibility for that to the Army reactors branch.

Senator ANDERSON. How would we know how to get along in this world? It is labeled "Military type experiment" on your own report. When we question you about it you say it is a mistake.

Mr. DAVIS. No, sir; it is not a mistake. I am explaining why it appears in this category.

Senator ANDERSON. Is it not the military?

Mr. DAVIS. It has a primarily military objective.

Senator ANDERSON. These people want some peacetime application.

Mr. DAVIS. It is our feeling that this particular reactor has possibility for peacetime application, but at this stage——

Senator ANDERSON. The Hanford reactor has possibility for peacetime application, does it not?

Mr. DAVIS. Yes.

Senator ANDERSON. They all have, do they not?

Mr. DAVIS. Yes, of course. In this particular case we did not feel we would be doing anything differently if we put it in the civilian power reactor branch than if we put it in the Army reactors branch.

Senator ANDERSON. You think this is what we would be doing if we try to develop civilian power?

Mr. DAVIS. At this early stage; yes, sir.

Senator ANDERSON. We always get a qualification. Do you think this is the same as the peacetime application would be?

Mr. DAVIS. Let me go a little bit further. If the preliminary work that we do here during the next 2 years or so, should turn out that it was encouraging from the point of view of both military and civilian application, we would probably from that point on have separate projects, one directed toward military and the other toward civilian application.

Senator ANDERSON. You would do the military application first?

Mr. DAVIS. We have classified it as a military application at the start; yes, sir.

Senator ANDERSON. You do not question that it is properly classified, do you?

Mr. DAVIS. It was a matter of judgment and this is the way it was classified.

The CHAIRMAN. Mr. Cole?

Representative COLE. No questions.

The CHAIRMAN. Mr. Price?

Representative PRICE. Dr. Libby, how did the personnel in the companies that are now engaged in this program develop to the position where they are now experts in the field?

Dr. LIBBY. They have done it by hiring people and taking people from the normal business and assigning them, and they are good people. They have done a good job.

Representative PRICE. Would you not say a company like the American Car Foundry, the Alco Products, Allis-Chalmers, Austin, Bechtel, and Dow Chemical are pretty big organizations?

Dr. LIBBY. Yes; surely.

Representative PRICE. Could you not put some sort of reliance in their opinion that they could quickly assemble and furnish top personnel and qualified personnel to take over one of these projects?

Dr. LIBBY. Mr. Price, taking Bechtel, Senator Anderson referred to the telegram the committee sent last year. I read to you on page 525 of your green book on the hearings on the Gore-Holifield bill, they wired you:

> Reference your wire May 29 subject consideration by your committee of proposals for acceleration of civilian reactor program. First: Bechtel Corp. has experience in atomic-energy program and are currently engineers-constructors for General Electric on Commonwealth Edison Dresden nuclear powerplant.

Second: We are qualified to assume full design and construction responsibility for a reactor project requiring only the type of technical collaboration which is primarily available from prime manufacturers of reactor and nuclear components. Our availability is subject to timing of project and subject to prior commitments of our engineering and technical personnel.

That is the point I am making.

Representative PRICE. Of course, Bechtel is only one of the numerous companies which replied to Senator Anderson's query. What about Allis-Chalmers, American Radiator & Standard Sanitary, Dow Chemical, and big organizations like that? Bechtel is just one of numerous replies received.

What about Dow Chemical? You said a moment ago the chemical companies were not interested. It seems to me there are numerous companies throughout the country that are qualified and have the organizations that could do a good job if called upon to do so.

In the first place, you would enter into a contract with these people, you would set forth certain requirements. I do not think a company like Allis-Chalmers, for instance, would make a contract with you unless they thought they were in a position to deliver on that contract.

I do not think Dow Chemical Co. would either.

Dr. LIBBY. In research and development work, it is practically impossible to write a contract which specifies the progress you must make. When you are doing research, you just cannot say what the discoveries you will hope to make are. You certainly cannot hold people if they do not make them.

You can put up certain standards of performance and hold them to it, but you cannot hold them to exceptional and unusual performance.

Now, in order to accomplish some of these objectives that we have in mind, we have got to have exceptional and unusual performance.

Representative PRICE. The point I am trying to get at, is that you probably had similar misgivings about every company that came into this program as they came into it. And yet, almost every one has delivered in a most satisfactory manner.

Dr. LIBBY. Well, they have done very well; yes.

Representative PRICE. I think the more industry you get into the program in this way, the more experienced people you are going to have. You will continue to have good luck, I think, in producing more and more people who will become experts in this field.

The CHAIRMAN. Mr. Holifield.

Representative HOLIFIELD. I would like to take up one other point. On pages 5 and 6 of Mr. Libby's statement, you bring out the fact there, or you stated the philosophy that—

The Government incurs a power deficit when it builds its plants on sites where firm power is required, and the experimental power these plants furnish has to be supplemented by firm power purchased from the normal sources. In other words, the power produced in these plants may be valued at little more than dump power. Therefore, a plant which might be built and incorporated, as the Shippingport plant, into a large commercial network with variable power demands, would, if built at Oak Ridge or at Hanford where firm power is an absolute necessity, create a deficit of many mills per kilowatt-hour. This, over the lifetime of the plant, might amount to as much as the cost of the entire structure.

In other words, the $100 million estimate Mr. Murray makes for the construction of each of these three plants may well have to be doubled in terms of the cost of firmed power before the project is over. Loss of this magnitude is a serious weakness of the plan. The same plant, if built at a location which would allow its incorporation into a commercial power grid in a partnership

arrangement with a power company, might save the taxpayers around $100 million in deficit financing.

Of course, all of these statements, I suppose, on both sides of the question, must be considered in relation to a point in time and to the importance of whether, from an international standpoint, we should get on with the job or not.

But I want to ask you this question:

Here we have the Shippingport plant turning its thermal kilowatts into a commercial network. Now, whether it turns those in on a firm basis or an intermittent basis, it is true that every kilowatt, whether we consider it in terms of the thermal units or the electrical units, represents a deficit to the Government?

Dr. LIBBY. Not directly, as I understand the contract.

Representative HOLIFIELD. As I understand the contract, the Shippingport reactor is operated, is owned by the Government, and is operated by the Government. Is that not true? It is owned by the Government and operated under contract?

Dr. LIBBY. It is owned, but I think the power company operates it.

Representative HOLIFIELD. They operate it under contract with the Government, I suppose. It is a Government-owned facility.

Dr. LIBBY. They pay for the operation.

Representative HOLIFIELD. Now we will sell the steam to the Duquesne people at the conventional cost. Is that not true?

Dr. LIBBY. That is my understanding.

Representative HOLIFIELD. But the cost of that steam is much more than the conventional cost. Is that not true? The cost of that steam to the Government?

Dr. LIBBY. I believe so. How much more, I am not prepared to say.

Representative HOLIFIELD. Well, we know it is not economic. I think the cost of 50 mills per kilowatt has been used loosely, probably, in the hearings.

If we are selling it at 8 mills, let us say, to Duquesne, and it is costing the Government 50 mills to produce it, there is a 42-mill deficit for every kilowatt that goes into the Duquesne system being borne by the Government. Is that not true?

Dr. LIBBY. I think it is, largely.

Representative HOLIFIELD. So, regardless of where we build these reactors, whether we build them on power sites, on atomic facility sites and turn it either on a firm or intermittent basis into the use of the Government, or whether we build it and own it as we do in the Shippingport case and turn it into a commercial grid, in both cases there is a deficit involved that is borne by the Government?

Dr. LIBBY. Yes, but the deficit is larger in the one case than in the other, as I see it.

If you had to supply the diffusion plants at Oak Ridge Shippingport plant, you would have to have firm power standing by to take over in case this one has to be shut down for some experimental reason.

Representative HOLIFIELD. That is true in the case of Duquesne?

Dr. LIBBY. Not so true.

Representative HOLIFIELD. Duquesne have their firm power source. They undoubtedly are not depending upon a firm supply of thermal kilowatts, are they?

Does not the Government have the power to shut down the plant and experiment with it as a Government-owned facility?

Dr. LIBBY. Any power grid has a normal rise and fall in demand. That is not nearly so true of our big production areas, where they run night and day the year around at a steady level.

Representative HOLIFIELD. Do you mean to say that your load factor is not more level at Oak Ridge and Hanford than it is on a commercial grid?

Dr. LIBBY. It is much more level.

Representative HOLIFIELD. That is what I am talking about.

Dr. LIBBY. Yes.

Representative HOLIFIELD. Therefore, your absorption of it into the system, you know exactly how to depend on your absorption of any additional kilowatts into the system, it seems to me.

Dr. LIBBY. But if you have trouble with the reactor, what are you going to do? You certainly do not want to shut down a diffusion plant. So you have to have power under contract to come in and take over.

Representative HOLIFIELD. Certainly. I have never had the thought that any of these experimental reactors should be considered as a firm supply of power, because I think you would lose the great scientific benefit of them in that you would not be able to experiment with them, and use them when you did want to use them to turn the power into the grid.

Dr. LIBBY. My point is just that you have more elasticity in the case of a commercial power grid than you do in the case of one of our big production sites.

Representative HOLIFIELD. Well, of course, as I understand it, your Oak Ridge grid and your Hanford grid are tied in with commercial users as well as with Government users. There is a play back and forth. There is a complete grid in which I assume the power is used most efficiently by allocating it at periods of valley and peak use.

I just cannot follow your line of thinking in that particular either, Mr. Libby. Maybe I do not understand it.

Senator ANDERSON. On that same point, you speak of this difference in the cost. Is not the real difference that of who pays it finally?

In the Shippingport reactor, the Government is going to pick up the difference between the commercial value of this steam and what it is going to cost to generate it. Costs will be higher with Consolidated Edison, will they not?

It is just a question of whether the taxpayer pays it out of the General Treasury or whether the individual users on the project pay it themselves. Is that not correct?

Dr. LIBBY. It seems to me the difference is larger in the case of installation on our own sites. The deficit is larger.

Senator ANDERSON. You said here on page 5 that—

> The same plant, if built at a location which would allow its incorporation into a commercial power grid in a partnership arrangement with a power company, might save the taxpayers around $100 million in deficit financing.

Whatever it saved, the taxpayers would benefit, the people in that community. The people in Chicago support Commonwealth. People in New York support Consolidated Edison.

If the costs go against those three companies, for example, then you think it might be better for the local people in Detroit, Chicago, and New York to pay rather than the general taxpayer.

What is the distinction?

Dr. LIBBY. It seems to me the cost to everybody is less if you tie it into commercial power grid where you have variable demands than if you put it in at a big site like Oak Ridge and Hanford, where, without purchasing firm power as standby, you cannot shut the reactor down. It is just that simple point.

I may have overstated it, but I believe I am right in principle that it does cost more.

Senator ANDERSON. Can I come back with a question at this time: What is a reasonable time? You said maybe 1959?

Dr. LIBBY. I mentioned the year. It will be arrived at by considering——

Senator ANDERSON. The letter of the Chairman, Admiral Strauss, says:

> However, in the event that acceptable proposals from industry covering all the reactor types which the Commission believes are technically ready for full scale construction do not materialize in fiscal 1958, either as privately sponsored projects or power demonstration program, we plan to request at that time additional funds in order to proceed with Commission financed and controlled projects for completion by June 30, 1962.

Now, the end of fiscal 1958 is June 30, 1958. After that is over, you not only have a chance to evaluate them all, you come back in 1959 and ask for funds which you can then come in subsequently and work up programs for.

Is that the way it will work out?

Dr. LIBBY. I guess so; yes.

Senator ANDERSON. This is the letter of Admiral Strauss of January 4, 1957.

You have been around the Congress long enough to know if you are to come in for funds after the end of June 30, 1958, you are going to come in during the month of July, which is a pretty busy month. You might get funds at that time.

May I ask if you know any particular reason why this gas-cooled reactor was labeled as military?

Dr. LIBBY. I am sorry, I just do not know.

Senator ANDERSON. Would that be that it would be classified as "secret" and people would not find out what the costs were, by any chance?

Dr. LIBBY. I will have to ask the General Manager to answer that.

Senator ANDERSON. Was that the reason, so that kilowatt costs could remain classified?

Mr. FIELDS. No, sir. I believe the reason was given by Mr. Davis. It started out as an interest on the part of the Army for this kind of development. There was a common interest also on the part of the Civilian Power Branch.

Senator ANDERSON. You are not in confusion as to whether or not there is also an interest on the part of the Congress and the people in the peacetime development of atomic energy, are you?

Mr. FIELDS. No, sir; I am not.

Senator ANDERSON. Does not the President of the United States have quite a bit of interest in the peaceful development of atomic energy?

Mr. FIELDS. Yes, sir.

Senator ANDERSON. Would you feel that this interest in the Army overrode the interest of the President?

Mr. FIELDS. I would not think so.

Senator ANDERSON. Then why was it classified as military?

Mr. FIELDS. Because there was a military interest.

Senator ANDERSON. There is a military interest in the passenger automobile that the commanding general rides in but you do not classify it under the military.

The gas-cooled reactor will be classified, will it not, under this classification?

Mr. FIELDS. I do not believe it will be a classified project.

Senator ANDERSON. Yes; it is a classified project right now. Does not Aero-Jet regard this as classified?

Mr. DAVIS. There certainly would be some classified aspects to it.

Senator ANDERSON. Does Aero-Jet regard this project as classified?

Mr. DAVIS. Yes.

I might make one other statement.

One of the reasons for doing this was that we hoped that it could benefit more from the aircraft information by so classifying it than otherwise. In other words, it can go through the stage of becoming a military project, and we can extract from it the information which will go to the civilian project.

It is certainly our intention to take all the information that comes from it that we can possibly release and declassify.

The CHAIRMAN. Will the military pay for it?

Mr. DAVIS. This is financed by the AEC as a part of the Army Reactors Branch program.

The CHAIRMAN. The Army comes in and asks for funds?

Mr. DAVIS. No, sir; we fund for this ourselves. They merely state a requirement, and we have such a letter from them stating their requirement.

The CHAIRMAN. You have the authority to make the classification, do you not?

Mr. DAVIS. Yes.

The CHAIRMAN. The Commission had the authority, not the Army. Is that correct?

Mr. DAVIS. Yes; we have this authority.

The CHAIRMAN. You do not have to classify it if you do not want to?

Mr. DAVIS. It depends on what the information is whether it is classified or not.

Mr. STRAUSS. Mr. Chairman, I am sure Senator Anderson would not want the record to indicate that the cost of this reactor is concealed from the Joint Committee.

Senator ANDERSON. No. It is the cost of the current that it produces that will be classified.

Mr. STRAUSS. No, sir; not to the Joint Committee.

Senator ANDERSON. I know, but if the Joint Committee gets it as classified information, then it cannot pass it on either. The people are the ones who want to know about this stuff.

Mr. STRAUSS. The cost of the current that this reactor produces—is that correct? It will not produce current.

Mr. DAVIS. This has no current, no power.

Senator ANDERSON. Then we do not have a gas reactor that is trying to develop power; is that right?

Mr. STRAUSS. That is the aim of this reactor.

Senator ANDERSON. Now we find out it is not designed to produce power. Is that right? Mr. Davis, is this designed to produce power?

Mr. DAVIS. Our gas-cooled reactor experiment that we are contemplating is a facility for testing out fuel elements which will be developed for gas-cooled reactors at high pressures and high temperatures. It is an experiment primarily to develop the fuel-element technology.

Senator ANDERSON. Then it is not a reactor primarily for the development of peacetime power?

Mr. DAVIS. The application of this could be either to military or peacetime power.

Senator ANDERSON. Then it is not primarily a reactor for civilian power?

Mr. DAVIS. It has a duel purpose, let us say. [Laughter.]

Senator ANDERSON. The Chairman of the Commission is opposed to dual-purpose reactors. You must bear that in mind.

Mr. STRAUSS. It is like any other experiment. It is aimed to the eventual development of power, but one canot say that this specific installation is a powerplant. That is the answer.

The CHAIRMAN. Any further questions of Dr. Libby?

If not, Mr. Vance, you are our next witness. You may proceed with your statement.

Mr. VANCE. Thank you, Mr. Chairman.

I welcome this opportunity to express my individual views as to how we can best advance the development of competitive, and therefore economical, sound nuclear power in this country.

I should like to speak first about what I conceive to be a desirable international policy because I believe that, by so doing, by contrast if you please, it will be clearer what our national or domestic policy should be.

Recently, we had a visit from the "three wise men" representing the six countries in Western Europe which are now happily joined in the coal and iron community, which are now in the process of forming Euratom, a similar cooperation effort in the atomic-power field, and which are now in negotiation looking toward the formation of a common market.

All three of these steps are, we hope, steps toward an economic and even a political union of the principal countries of Western Europe—France, Belgium, Holland, Luxembourg, Italy, and Western Germany.

The well-being of this group of countries is of great importance to us and to the rest of the free world because, as an area, they contain basic industrial capabilities which, if shifted from one orbit to the other, might be decisive in the struggle now going on between the East and the West.

Even now Western Europe is seriously short of fuel for power. Even now it is necessary for this area to import the equivalent of 100 million tons of coal at a cost of $2 billion per annum. It is estimated that by 1975 this burden will rise to the almost impossible level of 300 million tons of coal costing $6 billion per annum, except for such relief as may come from the extensive development of nuclear power in the intervening period.

When you consider that imported fuels must be paid for in hard currency, when you consider the hazard inherent in substantial dependence on imported fuels, as is so clearly demonstrated by the Suez affair, you will understand why it is imperative that Western Europe develop nuclear power in very large quantities as quickly as possible, and why, during the next few years, Western Europe must subordinate technological progress and the fruits thereof to the pressing need for power almost at any cost.

In many other foreign countries, economic considerations are of the same character, if not of the same magnitude, as those which are influencing the nuclear power program of the Euratom countries.

From our conversations with them, I am sure that the "three wise men" would prefer to see their countries adopt a program similar to ours wherein the benefits and results of research are more widely available before the construction of large power installations is undertaken. This is evidenced by the fact that their overall program is divided into two phases, that the second phase is much larger than the first one, that they hope and expect to enjoy the benefits of our research program as such benefits will come during the next few years before reactor types and designs have to be set for the second and larger phase of their program.

But under the circumstances which confront the "three wise men," there is but one course which they can recommend to their constituents. It is that they should, without delay and without waiting for results from their research or ours, select 1 or 2 types of reactors out of the many under study and proceed as quickly as possible with the design and construction of large power-producing units.

Time is for them more important than some possible reduction in either capital or operating cost to be expected to materialize at a later date.

I hasten to say at this point that conventional power, when produced from imported fuels in Western Europe, costs half as much again as the average of such costs in our own country—on the order of 12 mills against 8 mills—so that a nuclear installation which, in the present state of the art, would do some violence to sound economical considerations in our own country would not do so in Western Europe.

Now, our domestic situation is quite different. We are blessed with large supplies of coal, oil, and gas. They are relatively cheap and are fairly well distributed in relation to power demand.

It follows that we are not under the same pressures as our foreign friends, and we are free, at least so far as our economy is concerned, to follow a plan which, as in the fable of the tortoise and the hare, may appear to be slow at first, but which will win out in the end of the race.

The Atomic Energy Commission, with industry participating, is now engaged in an intensive exploration of a wide range of different

reactor concepts. We know that in the final analysis, all of them will not prove to be of equal merit even though as of now all appear to have interesting possibilities, else they would not be included in our research program.

The principal objective of our domestic program is finding out which type or types of reactors hold the most promise of being capable of producing competitive power or more than competitive power and, in addition, have the important characteristics of simplicity, reliability, safety, and low capital cost. For the time being, while this process of selection is going on, the production of power itself is of secondary importance.

We are fortunate, indeed, that we can in this period give primary importance to research and technological development, and we would be foolish, in my opinion, not to avail ourselves of that good fortune.

I should like to emphasize again the sharp difference between the situation abroad and the situation at home and to point out to you that, because of this difference, a program suitable for other countries is not now suitable for our country, and vice versa. Failure to recognize this simple fact is responsible, I believe, for some of the questions which have been raised about the adequacy of our domestic power program.

The plain fact of the matter is that we need 2 programs instead of 1. We need 1 for ourselves and 1 for our foreign friends, each tailored to fit a different set of circumstances.

I have already said that we have an interest in the well-being of Western Europe, and we have, too, in the well-being of other free countries. Helping them to meet their urgent needs for power may well become an important element in our international relations. I am not suggesting that this help should be on a giveaway basis.

With only modest cost to ourselves, we can make our technological knowledge available to our foreign friends, we can assure them of our willingness to supply them with nuclear fuels, to give them at reasonable cost necessary services such as the chemical processing of their spent fuel elements, to provide a market for plutonium and other fission byproducts, and finally, in accordance with an announcement made last October by the Export-Import Bank and ourselves, to make sound loans for the construction of nuclear powerplants as we have been doing for some time for the construction of steam and hydro powerplants in various parts of the world.

All of this is the kind of aid visualized by President Eisenhower when he made his memorable speech to the United Nations on Atoms for Peace in December 1953.

For the reasons stated I believe that we should have a clear and vigorous international nuclear power policy.

Now, as to the correctness and the sufficiency of our domestic program: At this time we cannot guess with any confidence which type or types of reactors are going to be best able to match the relatively low cost of conventional power which prevails in most parts of our country. Some reactors appear to have the ability to operate at high temperatures, which usually means at substantially lower costs. But by the very fact that they have this high-temperature ability, they present serious problems in metallurgy which are far beyond the present frontiers of settled metallurgical knowledge.

Thus, with regard to each reactor concept, its possible advantages seem to be matched by problems of the same order of magnitude, and many of these problems are beyond the area where scientific knowledge shows a road, a path, or even a blazed trail.

Of course, this program of research looking toward selection cannot go on forever, and the logical question is, When can we expect to be able to proceed with a large commercial program in our own country?

My guess is that another year and a half or 2 years will see us on the road, and that each year thereafter we shall be further along it. We know that full development of low-cost atomic power cannot come from research alone; it can come only from research combined with practical development.

It is my belief that at this stage little information can be obtained out of the design, construction, and operation of large reactors which cannot be obtained from the design, construction, and operation of small prototypes. Certainly this is so with respect to the fundamental problems which remain to be solved.

So long as atomic power is high-cost power in a relative sense, it is but good business to locate it where conventional power is also high-cost power.

It did not just happen that the Commission's plants, which are large users of electric power, are located in low-cost areas. To locate atomic power units in these areas substantially increases the economic penalty of operating them without any corresponding advantage except the avoidance of the public versus private power question. This economic penalty—that is to say, absorbing the difference between high-cost nuclear power and low-cost conventional power—is a very substantial one.

With respect to the location of nuclear powerplants at Commission installations, it is pointed out that the irregularity of nuclear power would make it necessary to retain full demand service from present power sources, with the result that nuclear power would have to be sold back to such sources at what are known as dump prices.

I believe that in the period immediately ahead the Government's role in the development of commercial nuclear power will be most productive if it is largely concentrated on research, on finding out which type or types of reactors are the best as a necessary precedent to sound commercial development; in short, the program which we are presently and vigorously pursuing.

The CHAIRMAN. Thank you very much, Mr. Vance. Are there any questions? Mr. Van Zandt.

Representative VAN ZANDT. Mr. Vance, on page 3 you say that—

> Under the circumstances which confront the "three wise men," there is but one course they can recommend to their constituents. It is that they should, without delay and without waiting for results from their research or ours, select 1 or 2 types of reactors out of the many under study and proceed as quickly as possible with the design and construction of large power-producing units. Time is for them more important than some possible reduction in either capital or operating costs.

and so forth.

Now, did they indicate in their conversations with you the experience that an American manufacturer had with the Japanese Govern-

ment when the American manufacturer tried to sell a reactor to Japan?

Mr. VANCE. Did they?

Representative VAN ZANDT. Yes; the "three wise men."

Mr. VANCE. Not to my knowledge.

Representative VAN ZANDT. Then, they did not have the benefit of that experience?

Mr. VANCE. No.

Representative VAN ZANDT. And they indicate the type of reactors in which they were most interested?

Mr. VANCE. So far as I am aware, they came over here with an interest in the whole field of reactors, and wanted to make their own assessment. It was my impression at the conclusion of their visit that their interest was largely, by that time, concentrated on what is known as the pressurized water-type reactor.

Representative VAN ZANDT. Now, on page 5, you say:

> We need 1 for ourselves and 1 for our foreign friends, each tailored to fit a different set of circumstances.

Could you go into more detail on that suggestion?

Mr. VANCE. What is that?

Representative VAN ZANDT. On page 5, when you emphasize the sharp differences between the situation abroad and the situation at home, you say:

> We need 1 for ourselves and 1 for our foreign friends, each tailored to fit a different set of circumstances.

Mr. VANCE. I thought in my paper I had made it perfectly clear what that difference was. I am sure that if we were situated economically as is Western Europe, if we were required to import coal for the same percentage of our power needs as they are, if we had the same economic dependence on importation of fuels, and had been up against the Suez situation, as they are, that our aims and objectives in this business would be quite different and would probably follow the lines which these men are thinking.

But I think it is very fortunate that we do not have that situation, that we do not have these pressures.

Representative VAN ZANDT. Are you familiar with the experience that the American manufacturer had in his dealings with Japan?

Mr. VANCE. Indirectly.

Representative VAN ZANDT. Is it true that what Japan wanted was a package proposition?

Mr. VANCE. I understand that is true; yes, sir.

Representative VAN ZANDT. When you suggested that we need "1 for ourselves, 1 for our foreign friends, each tailored to different sets of circumstances," is it possible now to come up with a package proposition so that we could meet the British competition?

Mr. VANCE. I would think, Mr. Van Zandt, that we might not be able to tie the package up in the same way that they have, but that is not the important thinking. If we can cover the principal elements in the package, then tying them up into one proposition, I think, is relatively unimportant.

Representative VAN ZANDT. How soon can we put together a package proposition? I asked that question of a couple of manufacturers 2 months ago, and they hesitated to answer.

It seems to me, if we are to meet the British competition abroad, we are going to have to offer a package proposition.

Mr. VANCE. I do not think it need be a package, as such, so long as we are able to cover either from two or more directions the high points which are of necessity in the minds of these people.

No. 1, for example: How much can they depend upon their fuel supply, assuming that they decide to go the enriched uranium route, as we are going?

I think that is of great importance. Why should they contemplate building a plant, the useful life of which they would expect to be at least 20 years, unless they could be sure that over that 20-year period they would be able to get the fuel replacements that would be necessary for continued operation?

Until such a time as they themselves might install their own chemical-processing facilities, I would think it is important that they know that they can rely upon obtaining those services from us.

Representative VAN ZANDT. Can they rely on Great Britain, at present, to provide them those services?

Mr. VANCE. I understand that they can; yes, sir.

Representative VAN ZANDT. On page 7, Mr. Vance, you say, when speaking of material:

> They present serious problems in metallurgy which are far beyond the present frontiers of settled metallurgical knowledge.

and you have reference there to the lack of the general knowledge that we have in this field.

What is the AEC doing to expand its research in this field?

Mr. VANCE. I think Dr. Davis should answer that question.

Mr. DAVIS. We have had for a number of years a metallurgical program as part of our engineering development work. I cannot quote the figures, but this has been expanding steadily over the past few years. Of course, each one of the projects, when we get into a project, undertakes the specific metallurgical development work for its own particular requirements. These two added together make a very large program in materials and metallurgy today.

The difficulty is that we are dealing with materials about which very little is known. We have had to develop a wholly new technology on zirconium, for example, starting out knowing nothing, literally nothing, about it. Now, today, it is becoming a fairly well-developed technology, but there are still many unknowns. This is simply a process that requires a great deal of time and has many surprises in it, as well as some things which please us.

Representative VAN ZANDT. This bottleneck was in existence this time last year.

What has the AEC accomplished during the past 12 months to help relieve this bottleneck?

Mr. DAVIS. I do not know that I can point to any specific examples, but there has been a continuing and expanding program of developing new materials, new alloys, getting new sources of supply, carrying out radiation and corrosion tests of alloys.

I think our knowledge in the overall sense is 30 or 40 percent more now than it was a year ago. But it is something that is a very broad

program. We are not dealing with 1 or 2 particular materials, or 1 or 2 particular circumstances under which they will be used.

Many of the things that have happened during the last year have illustrated that we do not know everything that we should know about these materials. Many of our problems and many of the delays we have had in the reactor program have come about just because of that.

Representative VAN ZANDT. My concern in that statement is probably strengthened by the fact that we have looked at 3 or 4 projects this year, and in each of those projects the barrier has been the bottleneck in this particular field. Until we relieve that bottleneck or remove it entirely, we are not going to make too much progress in these four projects I cannot mention at this time.

Mr. DAVIS. Probably our most important problem in the development of reactors is to get satisfactory, yet cheap, materials, and cheap in the form in which they appear in the reactor, and not necessarily in the form of billets lying out in the yard.

Representative VAN ZANDT. I have no further questions.

The CHAIRMAN. Mr. Vance, at the bottom of page 5, you say:

> I have already said that we have an interest in the well-being of Western Europe, and we have, too, in the well-being of the other free countries.

Then, further down in your statement, at the bottom of the page, next to the last paragraph, are these words:

> For the reasons stated, I believe that we should have a clear and vigorous international nuclear-power policy.

I gather from that statement that you do not feel that we have a policy at the present time. In reading your statement, you state:

> I am not suggesting that this help should be on a giveaway basis. With only modest cost to ourselves, we can make our technological knowledge available to our foreign friends; we can assure them of our willingness to supply them with nuclear fuels.

What are we doing? Are we doing any of the things you suggest there?

Mr. VANCE. Yes; I think we are, Mr. Chairman. You asked me if I think we have no policy. No; that is not the case, but I do believe that the importance, from the standpoint of our international relations, of helping other countries to develop nuclear power is so great that our policy should be pointed up, and should be made more vigorous and more specific than it is at the moment.

The CHAIRMAN. You are not satisfied with it at the present time, as I gather from your statement.

Mr. VANCE. I am not satisfied?

The CHAIRMAN. Yes.

Mr. VANCE. No, sir. I am seldom satisfied with anything.

Representative COLE. Find out what ails it, Mr. Chairman. What do you think we ought to do that we are not doing in the international phase?

Mr. VANCE. Well, rather than any one major thing, I think it is a series of smaller things, Mr. Cole. For example, at the present time, our power bilaterals, such as we have, are limited to a 10-year period. Trying to put myself in the position of the man in the other country, I believe that if we are going to make our best effort to have America lead the development of peaceful use of atomic energy in the rest of

the world, rather than the United Kingdom, I believe that we should be in a position to promise them their necessary fuel supplies for a longer period than 10 years. I think it should be at least 20 years. It might better be 25, but it should be for the estimated useful life of the installation, plus, perhaps, if we have to have a starting date before the installation is operational, then maybe 25 years would be the better time.

But I think for good men in other countries—and I might say in that connection I was very much impressed by the so-called three wise men—for good men to recommend that in their countries large investments be made in the development of nuclear power, with the type of reactor requiring enriched fuels, and knowing from that very fact they could in the foreseeable future get their fuels only from us, I think that long-range assurances would be very important in their making a decision as to whether, for example, they would recommend the pressurized water reactor on the one hand or the British gas-cooled type on the other.

The CHAIRMAN. At the present time who is running this program? Is the Commission running it, or some other agency of the Government?

Mr. VANCE. I think the Chairman should answer that question.

The CHAIRMAN. Mr. Chairman, can you answer it?

Mr. STRAUSS. The Commission is charged with it by law, and the Commission is operating it in cooperation with the State Department, the International Cooperation Administration, and such other agencies of the Government as may from time to time have an interest. But my understanding, Mr. Chairman, is that the primary responsibility rests by law with the Commission.

The CHAIRMAN. In other words, you have the authority to lay down the policy.

Mr. VANCE. At the direction of the President and with the approval of the Congress; yes, sir.

The CHAIRMAN. Senator Anderson.

Senator ANDERSON. I do not want to take the exact words, but I note your statement at the bottom of page 4, that—

> The principal objective of our domestic program is finding out which type or types of reactors hold the most promise of being capable of producing atomic power.

As to the remark Mr. Van Zandt made in reference to the difficulty of manufacturing, I want to go back to what the Japanese said on January 17 about taking future developments in the United States, and so forth, into full consideration:

> It is advisable that the first step to be taken by our country should be to introduce a British-type power reactor, a large prototype of which has been completed, and for which technological and economical problems involved therein can easily be explained.

You have had long experience in the automobile business. How far did Mr. Tucker get with his car that was going to be built, compared to people that had cars that had been built?

Mr. VANCE. You know as well as I do he did not get very far.

Senator ANDERSON. And, if you had automobiles to sell, would your salesmen do very well if they went out and said, "We are about to produce this kind of automobile for next year," and ask your cus-

tomers to buy it, or were they interested, as I was, in reading the magazines and newspapers of results of the trials in Daytona to see how many Chevrolets came in and how many Pontiacs and what happened to the heavy Chrysler. Do you not think that has some bearing on the other countries, the completion of this model?

Mr. VANCE. I would like to answer your question in this way: In the little over a year I have been with the Commission, the thing that impressed me more than anything else with respect to this subject we are discussing this afternoon is the operating record of the *Nautilus*.

Senator ANDERSON. Yes, but how about the operating record of the *Seawolf*? It had a land-based prototype that operated equally as well. Then they put it into a submarine and it did not, somehow, work.

Mr. STRAUSS. There was nothing wrong with the nuclear components on the *Seawolf*. This was, I am informed authoritatively, completely independent of the reactor and the functioning of the reactor.

But might I say, because I think you will be interested, that the Japanese statement to which you have referred, made in mid-January, is, we are informed, superseded. There is a new chairman of their atomic-energy authority, and his most recent statement was to the effect that they were coming back here before deciding on the type of the first reactor to be installed in Japan. Our further information is to the effect that no order has been placed anywhere.

Senator ANDERSON. Again, we can only judge by what they have announced openly and publicly.

Mr. STRAUSS. There has been a public announcement to the effect that I have just stated.

Senator ANDERSON. I do not question that. But I was impressed by this, because it seemed to indicate what a great many of us had feared, that the British might get the jump pretty badly on us in the production of these devices.

May I call your attention also, Mr. Vance, to the item which has been referred to on page 5, toward the bottom:

> The plain fact is that we need two programs instead of one. We need one for ourselves and one for our foreign friends, each tailored to fit a different set of circumstances.

I only want to say in comment that there was a bill, S. 4146, that passed the Senate, got to the House, that had in it a section entitled "Foreign Atomic Power Assistance."

Pointing out that in order to effectively carry out the atoms-for-peace plan of the United States, the Commission shall have responsibility for the conduct of a vigorous program in international cooperation and assistance in the design, construction, and operation of power reactors and related matters.

It provided also for supporting facilities and things of that nature.

So what you have just said, I think, finds a hearty response in the minds of a good many members of this committee. We would like to see it under way.

We recognize there is a great economic difference in the construction of these and the feasibility of these in rather high-cost-power countries and the situation in this country where we have low cost.

Now, I am a little worried again about this question that seems to bother Dr. Libby. I would like to ask you because of your long industiral experience.

You refer to this location of atomic powerplants in certain areas, low-cost areas, and say:

> With respect to the location of nuclear powerplants at Commisison installations, it is pointed out that the irregularity of nuclear power would make it necessary to retain full demand service from present power sources, with the result that nuclear power would have to be sold back to such sources at what are known as dump prices.

Could you explain that a little further?

Mr. VANCE. Yes, sir; I will.

A large electrical distributing system, according to my understanding—I have never had experience in this field—I understand it is desirable in a large electrical distributing system to have no more than 10 percent, and preferably no more than 5 percent, of the total power generated coming from one unit.

Now, the reason for that is perfectly obvious. That is so that putting one unit out of commission is not going to seriously disturb the whole system.

Furthermore, it is my understanding as a matter of practice that systems do not contract under what is known as a demand basis for more than a percentage, possibly 80 percent.

That may not be the correct figure, but they do not contract for 100 percent of their capacity. The rest is in reserve and is to take care of breakdown and what have you, all of which, it seems to me, makes sense.

Now, I think, therefore, it is one thing, Senator, to have a unit of this sort as part of a large system where it can, if its operation is interrupted, take the same status as would a corresponding reserve of the conventional type.

I think that we would have to look at a situation where the Commission generated power, as, for example, at Oak Ridge.

I think we have to look at it as though that power unit were part of the TVA system and not part of Oak Ridge operations, Oak Ridge being a consumer of power and under the necessity of having a constant powerload.

Senator ANDERSON. That is very interesting because this is exactly what the bill took into account, precisely. You have described exactly what was in the minds of those of us who favored it, because the generation of current from the Tennessee Valley Authority runs into the millions of kilowatts and this plant that might be built at Oak Ridge was going to run 100,000.

I do not have to tell you that 100,000 is far less than 10 percent of millions of kilowatts and so we are doing exactly, as the Bible said in St. John to the Corinthians:

> That which you have worshipped without knowing come I to declare unto you.

That is what we were trying to get down and that is what the Commission was opposed to do.

The same thing applies to the Columbia Valley. If you check the current output from the Columbia Valley area, a small plant at Hanford would not have greatly disturbed the general situation and would not necessarily have been dump power.

That is why I do not like this term in here because it would not have been "dump power" at Hanford and it would not have been "dump power" at Oak Ridge and your very language proves it.

Now, as to other areas, what about Argonne? You have 5,000 kilowatts at Argonne tied into the Commonwealth-Edison system. Do you think that is all right?

The principle is exactly the same as taking a small amount at Oak Ridge and tying it in Tennessee Valley.

Mr. VANCE. I don't know what the cost of power will be out of the small reactor out of the Argonne Laboratory. But I do know that the location geographically is in a very much higher cost area than is Oak Ridge or Hanford.

Senator ANDERSON. I regret to say to you that my particular part of the country is in a much higher category and some of us are beginning to feel it and worry about it a little bit.

Mr. VANCE. I would like to see the first series of commercial reactors in this country built in high-cost power areas, not in low-cost power areas.

Senator ANDERSON. The hope was that there might be built where the very thing we are talking about would be done; namely, there at Oak Ridge where Oak Ridge buys a tremendously lot of current from various other places it might be provided most easily in that grid just as Argonne does theirs.

I think we would all agree that we do not want to build a large plant somewhere and completely absorb the market for a short time and then have to build some other kind of standby power to take its place.

I do not think we want that, either.

On the whole, I think I agree very heartily with the statement you have made here.

The CHAIRMAN. Mr. Price?

Representative PRICE. Mr. Vance, on page 5 of your statement, you say:

> Failure to recognize this simple fact—

talking about the sharp difference between the situation abroad and the situation at home—

> is responsible for some of the questions which have been raised about the adequacy of our domestic-power program.

That may be true of some people outside of our committee, but I think everyone on our comittee is familiar with both situations and has raised no question about the adequacy of our domestic-power program insofar as it is necessary to meet a domestic-power requirement. I don't think there is anyone that is stressing the urgency of the development of power-reactors program on the basis of domestic needs.

Mr. Van Zandt and myself have enough coal in our districts to take care of that for a good many years.

But there are a good many people concerned with leadership on the international plain in the development of electrical energy through atomic power.

Do you feel that economically and politically in the world affairs that it is important for us to obtain and maintain leadership in this field?

Mr. VANCE. Yes, sir; I do.

I would like to see us do it with the least cost to ourselves in dollars.

If you will allow me to explain what I meant by this particular sentence that you read, Mr. Price, what I meant was this:

At least in the short time that I have known anything about this atomic energy business, I have as each month has gone by, gained a clearer idea of why, for instance, Britain has the type of program it has and why we don't. I am quite sure that if we were Britishers sitting here today confronted with their economic program, our discussion would be of an entirely different nature than it is.

Representative PRICE. Is it not a very interesting point, that even though the British have a domestic need for the development of atomic power, that their thinking goes far beyond the domestic need and they are looking upon this as a means of international trade, development of greater international trade for Britain in a new field?

Mr. VANCE. I would like to say, first of all, that I am not sure that their program of development goes beyond their economic needs. I don't think it does.

Representative PRICE. I think we have seen great evidence of that every time we have been in contact with them.

Mr. VANCE. I think your point is a little different. That is that their view of the future was not limited to their own economic needs, but they also had a view of being the leaders in other countries. That is what you meant, I believe.

Representative PRICE. Yes; that is correct.

Mr. VANCE. I think if we had the exchange problems that Britain had that we would have that kind of view, too.

Representative PRICE. Do you have a feeling that there is great importance for us to hold the leadership?

Mr. VANCE. I think it is very important that we should; yes, sir.

Representative PRICE. All through your presentation you have the statement that the essence of the situation abroad is time.

Mr. VANCE. That is right.

Representative PRICE. Now, we propose to coöperate with them and to assist them even though we recognize that their need is for quick development of atomic power, by just going along in our cautious fashion in research and development and through this period giving them more or less advice and counsel and the benefit of research.

Mr. VANCE. No, sir; I think we can go much further than that. I think that we have told the representatives of the Euratom group that we are prepared to go much further.

I believe, using a general statement that we have told them that we are perfectly willing to do anything within our resources to help them carry out this program.

Representative PRICE. Do you hold any concern that Britain or some other country might possibly fill their need before we do?

Mr. VANCE. Fill their needs?

Representative PRICE. Yes. Produce for them and build for them a feasible, economically feasible, as far as they are concerned, atomic power reactor.

Mr. VANCE. No, sir; I do not think so. I think in the first place that these men realize, I think they are smart enough to realize and I think their technical people who accompanied them very clearly realized, that the American approach through the use of enriched uranium is

by far the better approach than the natural uranium concept of the British.

I think, therefore, that all other things being equal, their technical recommendations would be for our type of reactor.

I furthermore believe, based on what Yankee is doing in New England, that these people could, at the present time, in the present stage of development, engage in a program of pressurized water reactors which would be almost, if not fully, competitive with the higher cost of conventional power which they have.

Representative PRICE. That is all.

The CHAIRMAN. Mr. Cole?

Representative COLE. I would like to find out more about your recommendations to firm up our foreign policy.

You have given me one. What others do you suggest?

Mr. VANCE. Yes, sir.

Representative COLE. I say, you have given me one recommendation to firm up a distinct foreign policy. Now, what other suggestions do you have? That is about extending the length beyond 10 years.

Mr. VANCE. Beyond those stated in the paper, you mean?

Representative COLE. You indicated that you thought the bilateral power agreement should run for 20 or 25 years in order to implant a feeling of stability and permanence in the minds of our foreign dealers?

Mr. VANCE. Yes. I also mentioned, Mr. Cole, that I think the same long-range assurance on chemical reprocessing should be given which I understand are not technically possible in the law at the moment. I would think that that is highly desirable.

I would think that to the extent that we can within reason we should assure them of a market for plutonium and the byproducts which would naturally come from the operation of their reactors so that is a credit that can be taken into their computations of what their net power is going to be.

Representative COLE. That is in the course of being firmed up now, is it not? I just judge from what Mr. Strauss said this morning, to buy back the material.

Mr. VANCE. Right.

Representative COLE. As well as the cost of the fuel processing.

Mr. VANCE. Of course, we are limited as to the time cycle, the length of time. I think that limit is 7 years.

Representative COLE. Are there any others that come to your mind?

Mr. VANCE. This is a rather intangible one, but I believe one that will weigh very heavily in the minds of our foreign friends.

I would like to repeat a statement I made in the paper to the effect that I think there was a purpose in their division of their program into two phases and a purpose in making the first phase as small as they thought they could and the second phase is a larger one.

This is based on some conversations I had with these men.

Now, I think the reason for it, the underlying reason for it was that they hoped that before they had to crystallize the designs which they would adopt for the second phase of their program, that some of the answers to these questions that we are trying to solve by research would be known to us and we would pass that information on to them.

And I think they should have our complete assurances that that will be done.

Representative COLE. They have not been given indication that it would be otherwise, have they?

Mr. VANCE. No, but I think we could reinforce our statement so that they would be sure that we understood what they have in mind and will cooperate with them.

Representative COLE. Reference has been made to the operation of the ICA in this foreign atomic program. Can you tell me, Mr. Vance, or perhaps the Chairman, just how ICA figures in this foreign atomic program and why?

Mr. STRAUSS. At the present time, Mr. Cole, the ICA is budgeting the sums which the United States contributes to the cost of the research reactor program abroad.

If you will recall that is an amount limited to half the cost of the reactors up to $350,000 in the case of each country.

They are cooperating in bringing foreign technicians and students here to study at the schools which we have established, and the ICA is responsible at the present time—I believe this statement is factually correct—for the establishment of the Asian nuclear center in Manila or the Philippines, announced something like a year or 18 months ago by our Government.

Representative COLE. Has the operation by ICA interfered or caused any slowdown on the sale of American reactors abroad?

Mr. VANCE. None at all, sir.

I have no reason to think——

Representative COLE. Or has it caused the slowdown of the firming up or finalization of the power bilateral agreements?

Mr. VANCE. No, they have no power in that. We obviously operate in consultation with the Department of State to be assured that the acts which we perform are in consonance with overall policy and this very afternon we are, as a matter of fact, signing an agreement of which notification came down to the Committee either on Saturday or this morning, with the Government of Norway.

Representative COLE. I would like to clarify in my own mind, now that we have Mr. Strauss back—I do not want to transgress on Mr. Vance's time—to clarify the extent to which a potential bidder of your third go-around may anticipate assistance from the Commission by way of dollars.

Mr. STRAUSS. By way of direct contribution of dollars?

Representative COLE. By way of assistance.

Mr. STRAUSS. There is no disposition on the part of the Commission, nor do I believe there is any legal authority available to the Commission to give any assistance to a company or public organization interested in building a reactor. There is no authority for financial assistance from the Commission in the form of a direct contribution to the capital cost of the reactor.

We are in a position, we believe, under our interpretation of the statute, to perform necessary research and development work which, however, is in the public domain once it is performed and is available not only to that particular institution, but to everyone.

Mr. Mitchel tells me that I have stated it correctly.

Representative COLE. How can I, a prospective bidder, know what sort of assistance I might anticipate from the Commission by way of these research-assistance aids?

Mr. STRAUSS. If you were a prospective bidder, Mr. Cole, I presume you would come in and discuss with the Reactor Development Division, the manager, the type of reactor in which you were interested. You would know, or there would be conveyed to you, the extent of the information that the Commission presently possesses in that area.

There would also be indicated to you the distance between the information in hand and the information that you would presumably need in order to obtain contracts from a contractor, or many contractors, to build your reactor.

The extent to which research and development should be carried on at Government expense to bridge that gap would then be the subject of negotiations between you and the Commission.

Representative COLE. That very last part is the one that is most uncertain.

Mr. STRAUSS. It will be uncertain unless the specific type of reactor can be brought into the discussion as an instance.

Representative COLE. The concept I propose to you is one that is of interest to us as being novel. Therefore, the entire project, the whole thing, is research and development.

Now, how does the Commission sit down with me and say, "Mr. Cole, the Commission will pay you X number of dollars representing X phases of research on this project"? How can you do that?

Mr. STRAUSS. I don't anticipate that the Commission would pay any number of dollars to the potential bidder under those circumstances. The Commission would undertake to conduct the necessary research to prove the points at issue if it was a type of reactor project which the Commission believed to be promising in the matter of being useful to the overall knowledge.

Representative COLE. Then, I take it, that statement that no research and development assistance is available from the Commission for the actual construction of the reactor concept.

Mr. STRAUSS. I am confused by your mention of research and development and construction. There is no money that would go from the Commission toward the bricks and mortar.

Representative COLE. If by bricks and mortar you mean the whole reactor as well as the building.

Mr. STRAUSS. Let me try to cite a case. Suppose, for instance, the potential bidder wished to construct a pressurized water reactor, orthodox in all of its concept except that there was a radical new core, and that the performance of that core and its design and its critical size were possibilities unknown to the potential bidder.

The Commission would, and in my opinion should, undertake to do that research at the expense of the Commission and for the benefit of that bidder and anyone else who wished subsequently to copy the plant.

Representative COLE. Having done the research on the core do you not feel that the Commission would be equally justified in saying to that prospective customer or bidder that the Commission would build the core itself based on research at the expense of the Commission?

Mr. STRAUSS. I think that might have been the state prior to the time that commercial firms had indicated a willingness, indeed a readiness, to build cores. I am informed—in order to avoid advertising I will not mention the name—that one concern has offered to

build cores of what we would now consider a standard type for something like 40 percent——

Representative COLE. I am talking about a special type.

Mr. STRAUSS. Well, they might even build a special type and their figure was something like 40 percent under the cost that the Government——

Representative COLE. That does not answer my question at all.

Mr. STRAUSS. I am sorry.

Representative COLE. The fact that the customer can go out and buy the core of a producer is not going to help him pay for that core. That is the thing that concerns him. Not where he is going to get it, but who is going to foot the bill. My point is, if the Commission is justified in footing the bill for the research which gives you the basis on which you predicate the fabrication of the core, if that can be justified and if that is the concept of the reactor which in the opinion of the Commission would enlarge the knowledge of the art, why is not the Commission justified in saying to the customer, "We will provide the money with which to build the core"?

Mr. STRAUSS. I think that should only be done if the customer, the applicants, would not build it, and I don't foresee that contingency.

It seems to me that is a part of the cost of the plant which should be borne and will be borne by the private industry.

Representative COLE. Well, it seems to me that the Commission is leaning over backwards to carry out the letter and spirit of that law, that says, there should be no subsidies.

How can you come in here as a Commission and say, "We have to get on with this business of research and development in the reactor art" and not be ready to at least recommend to the Congress that some public money be used to that end?

Mr. STRAUSS. There has been no indication that it is necessary in view of the very substantial number and size of the projects which have come to the Commission without subsidy since the Congress adjourned in the summer of last year.

Representative COLE. Yes; but the lion's share of those that have come in have all been predicated on the old conception of a reactor, not a new one.

Mr. STRAUSS. I would not say that that was so.

Representative COLE. For the most part.

Mr. STRAUSS. I think that the pressurized water reactor has appeared more frequently than others, but it is not more than half.

The CHAIRMAN. Mr. Strauss, let us get back to the foreign policy program. Can you tell us how many reactors, at the present time, have either been started under the program and if all of them had to be approved through the ICA in foreign countries; I mean research reactors?

Mr. STRAUSS. I think, Mr. Chairman, it was stated this morning that there were 16 such orders placed. But these are not cases where the entire cost of the reactor was requested in the shape of a grant-in-aid and the grants-in-aid to date only number four.

The CHAIRMAN. There have been four reactors where there have been grants-in-aid through the ICA.

Mr. STRAUSS. I wouldn't say through the ICA, but you are quite right it has been funded in the ICA budget.

The CHAIRMAN. Now, of course, the one that you are requesting, on which there has been no legislation, is for Berlin, and I understood they paid for that entirely.

Mr. STRAUSS. That is right, sir. They have offered to pay for the entire installation.

The CHAIRMAN. Could you give the committee the exact amount of funds that have been expended through the ICA for research reactors in foreign countries?

Mr. STRAUSS. I will have to supply that, sir. I don't have it.

The CHAIRMAN. Thank you very much.

Mr. Holifield.

Mr. HOLIFIELD. Mr. Vance, I want to say I believe we should have a domestic program and international program.

As you said here in one place, we should have two programs. I think that our domestic program and the whole theory of going into all of these different types of reactors and exploring them on the small scale, is a good theory.

I would see no reason at all to change it from that program if there was not some type of international compulsion.

Now, I have been sold the idea that there is some international compulsion from the standpoint of maintaining the prestige of the United States and this field because of maintaining the lead in the world against foreign competition. Once having been sold that concept, I felt that maybe our international program was slow and that we should be getting on with it.

I am troubled with the same thing that Mr. Van Zandt is troubled about, that in your statement here on page 6, I guess it is, where you enumerate six ways of helping our foreign friends, that you still have not wrapped it up in a package.

It seems to me that what these foreign nations that are not advanced in this program want is a package.

So I am concerned that if this is the extent of your assistance, of the program of assistance to the foreign countries, even including the extension of time limits as you discussed with Mr. Cole, that you are still short of a clear and vigorous international nuclear policy.

I cannot see how you can get that clear international nuclear policy to where it is effective in the foreign fields unless you do wrap it up in a package and deliver to these people what they actually want to buy, which is a practice which will produce kilowatts as cheaply as possible.

Mr. VANCE. Mr. Holifield, at the risk of repeating what I said before, I would like to say to you that I am sure that these potential foreign customers of ours are smart enough to be interested in the aggregate of various things they need in the way of assurances, guaranties, or whatever you call them, rather than how they are wrapped up.

Representative HOLIFIELD. What you are saying is that you think they will take the good things we can give them and such good things as maybe the English can give them, and that they will themselves coalesce those into a usable reactor.

Mr. VANCE. No, sir; I think the difference between the package and the components of the package, if you will, is this: My understanding is that in Britain the design and construction of all of the various

reactor installations that are planned has been put into the hands of 3 groups of companies and limited to 3. Each group consisting of a number of constituent companies, and that the Government—and I might say at that point that my understanding is that the British electrical authority is in effect the presumed operator of these reactors and the contractor for them—so that you have in Britain a situation where the Government is the sole operator, taking the place, if you will, of all the private and public operators in this country.

Then you have three consolidations of engineering and scientific firms. These three groups are the people who will design and construct British types of reactors abroad.

I think that you can get a package deal with that kind of setup that is very difficult for us to tie up into one package in the economic situation that we have in this country.

Representative HOLIFIELD. I agree with you.

Mr. VANCE. But I think, Mr. Holifield, the important thing is that we cover the same range and give the same assurances.

I am sure that if these people could see that in the boxes full of pieces that we offer them there is a complete picture puzzle, if you will, the fact that it is not put together would not concern them.

The fact that some of the assurances come from industry in this country and some come from Government, I don't think that is important.

Representative HOLIFIELD. We are in competition with England because of the unified approach they give to an outside customer. I think to a certain extent the same thing applies to Russia.

I am even more afraid of this in years to come because if Russia moves into these countries with a package, they will realize that the economy cannot produce the package even though they can get the spare parts from them.

So we are in a position of disadvantage in competition with international, quasi-governmental private combinations as they have in England and in Russia, and the only way I can see that we can overcome that and present a unified competitive article is for us to develop first here at home a working model of an article putting our own parts together into a demonstrable, efficient machine and then let private industry, any part of private industry, once having that knowledge and experience of building, can go in and do a good job of competing with England and Russia.

But I can't see how they are going to reach that point of presenting a competing package unless we give them a little boost.

That I think is the only difference that I have between your presentation and my own.

Senator ANDERSON. It would seem to me as I tried to listen to that colloquy that when Mr. Vance spoke of these parts that go in a box, apparently the British are offering a completed instrument and we are going to give them a do-it-yourself kit.

Mr. STRAUSS. The proof of the pudding is in the eating; we have the orders.

Mr. VANCE. This is the age of do it yourself, you know.

I am expressing only my personal opinion when I say this, Mr. Holifield, but I think we already have reached a point where we can offer to our friends abroad the pressurized reactors with confidence

on our part. I hope they have the same confidence by contact with us—that it has the possibilities of doing what they need, what they have to have.

Representative HOLIFIELD. You cannot do it on the one demonstration, the Shippingport demonstration, because it is a high cost producer.

You are talking about the pressurized water reactor. I am assuming you are talking of the improved model of the Shippingport reactor?

Mr. VANCE. Yes.

Representative HOLIFIELD. I do not see how you can present this to a foreign buyer until you have demonstrated that you have.

Mr. VANCE. I think that the foreign buyer is willing to take some chance.

Representative HOLIFIELD. I think we would make a mistake, I honestly think that American industry would make a mistake if we went abroad and built a number of uneconomic reactors. I am speaking about uneconomic on the basis of their kilowatt production cost.

For instance, if their costs are 12 mills and we could only get our reactors down to, say, 20 mills or 25 mills, something like that, and we would build 2 or 3 of these reactors abroad, I believe in the end it would boomerang on us and we would be more or less accused of taking advantage of them and putting a high-cost reactor into their hands unless we said in advance that this is not going to be an economic reactor.

Mr. VANCE. I agree with you if that were going to be the case, but let me suggest two possibilities to you.

One is this: I understand that one manufacturer in this country told the Japanese when they were here several months ago that a pressurized water reactor similar to the Yankee type could be made that in the estimation of this manufacturer would have a power cost pretty much in line with the cost of conventional power in Western Europe when it developed from imported fuels.

That is closer to 12 than to 20.

Now, the second point I would like to make to you——

Representative HOLIFIELD. Before you leave that, did the Japanese buyer accept that assurance of the manufacturer at face value and was the manufacturer willing to give him a guarantee that he would produce it at that cost?

Mr. VANCE. No, sir; I think not. I don't believe at this stage of the game that a customer has any right to expect a manufacturer to give a guarantee.

Representative HOLIFIELD. Did the—then the manufacturer has no right to expect the customer to accept his assurance because you are just dealing in conversation, you do not spend 15 to 100 million dollars on conversation.

Mr. VANCE. I think one simple reason why a manufacturer cannot give a guaranty of power cost is just this: Who knows today what the life of the fuel element is, of the core?

Representative HOLIFIELD. Who knows a lot of things? Who knows whether you can even start it off at a cost of 12 mills unless you actually build one like we have built at Shippingport, and had a least a brief period of operation to begin to get some statistical data on it.

Mr. VANCE. I would like to call your attention to this other point. I said I had two points to make in response to your question.

The second point is this: I can't help but feel there is some analogy between the development of nuclear power and the development of conventional power. I call your attention to the fact that this being 1957, that since 1939 there has been no change in the fundamental concept of the conventional powerplant. It is the same fundamental concept today as it was in 1939.

Yet in this period of time the cost of conventional power has come down 50 percent.

Now, what has caused it? No revolutionary discovery, no revolutionary change in the type of powerplant, but rather it is the cumulative effect of the little improvements, the refinements that have come from the building of a succession of conventional powerplants, each succeeding one being better than its predecessor.

I am sure that when the proper time comes that that same evolution is going to come in his field.

The CHAIRMAN. That would primarily be due to squeezing more B. t. u.'s out of the fuel; is that not correct?

Mr. VANCE. That is correct.

I would like to suggest, therefore, that if some of our foreign friends should choose to adopt the pressurized water reactor and build a series of that type of power installations and if we helped on the research, particularly on the research of cores, let us say, fuel elements, I believe that in the course of time that the efficiency of those plants would materially increase just as it has done in the conventional power field.

I think that some of our foreign friends who are wise men know that.

Senator ANDERSON. Can you refer to some testimony that came in while I was away. The testimony of the American Public Power Association, James Grahl testifying. I do not care who answers it. It says:

> We therefore are deeply concerned about AEC's third invitation for proposal because its terms have the effect of freezing out the local publicly and cooperatively owned utilities and, at the same time, stimulating the formation of additional large private utility combinations to sponsor nuclear power projects. This new policy also may restrict opportunities for expanded activity in the power reactor manufacturing field to the very large and wealthy industrial firms.
>
> The association recommends careful review of the terms of AEC's third invitation by this committee, AEC, and the Department of Justice to determine whether in the interests of avoiding monopolistic tendencies and strengthening competition, the invitation should be withdrawn or drastically modified.

Has the Commission commented on that testimony?

Mr. STRAUSS. We have not commented on it; I have not read it. This is a construction evidently placed on the third-round invitation by the witness.

We certainly had no such aim in mind at all.

Senator ANDERSON. I was very anxious to get that in the record at this point because I am sure that the Commission had no such thought. But in the second round you did make a provision in the type of assistance offered that financing and retaining title to all or part of the reactor system, and that proved to be very valuable in connection with these cooperatives out in Nebraska.

For example, by financing an entire part of the program, the same as Shippingport, by the fact that they are only building the transmis-

sion part of it, the generating part of it, and you are going to supply the fuel and steam and are going to charge a fixed price for it, you make it possible for them to operate when you and I know and everyone else knows it is not at this time commercially profitable.

Now, is there any significance in the fact that you have stopped the financing of a part?

I was interested because of Mr. Cole's question. He saw that there might be certain types of reactors that simply will never be built in this country if the Commission probably does not finance them, and as Mr. Cole pointed out, build the whole thing that might be new or revolutionary.

Was there any thought of leaving that sort of work out in the third round?

Mr. STRAUSS. No, and it is conceivable that we might experience a situation where we have a reactor type which we would like to see developed and where there will be no development of it by private capital.

As I testified, Senator, in May a year ago, under those circumstances we would propose to come to the Congress and ask for funds and authority to do it.

Senator ANDERSON. Need I tell you that I have talked for a long time on the basis of testimony of Mr. Zinn that the gas-cooled type offered some possibilities?

I am a little worried now to find that apparently what is going on is not directly in the direction of developing as fast as some of us thought it might be.

Would you think if the Commission desired to develop a gas-cooled type in a faster method that it might be a permissible thing for the Commission to go ahead and build it?

Mr. STRAUSS. I think we are committed to that very principle, that if we decide that a gas-cooled type should be built and that the state of the art is such that we are ready to do it and we cannot get it built other than at the expense of the taxpayers, we would undertake to try to get authority and appropriation to do it.

Senator ANDERSON. I hope you would not have too much trouble getting authority.

The CHAIRMAN. Thank you very much. Are there any other questions? I understand that Mr. Murray has a short statement he would like to give to the committee.

Mr. MURRAY. There may be some question about this, but since this morning I have had a chance to look over the testimony of two witnesses, one was here last week and the other submitted a report. I think it points up very clearly some of the reasons—maybe fundamental reasons—why it motivates me in trying to get on with this job.

With your permission I would like to read something here. [Reading:]

In my statement before this committee last Tuesday I emphasized the distinction between industry's time schedule and the time schedule required by the national interest in the development of industrial atomic power. The former is set primarily by this country's needs for electric energy. But the time schedule required by the latter is much shorter. It is set by the crisis in nuclear weapons and the world need for atomic power.

This need to emphasize this distinction again is indicated by Mr. Elmer L. Lindseth's remarks when he appeared before you last Wednesday. Speaking

on behalf of the Edison Electric Institute, its committee on atomic power, and its member companies which serve 75 percent of all electric users in the United States, he said:

"As additional opportunities or needs develop we expect that necessary further steps will be taken by our industry, with emphasis on advancing the technology and economics of nuclear power applications."

This is a sound statement insofar as it concerns the position of the great majority of the private utility companies in the United States.

From this point of view no one could quarrel with it. However, when the development of industrial atomic power is considered from the viewpoint of the national interest, I am convinced that the "opportunities" have already arrived and, furthermore, that the "needs" have already developed. In fact, as I tried to bring out in last Tuesday's statement, we may have already left some opportunities.

The matter of time schedule is the crucial and central issue in the question of the development of industrial atomic power. The question of time is the essential difference between the objective of the program in terms of the interest of the utility companies and the objective of the program in terms of the national interest.

Although Mr. Lindseth did not emphasize the matter of time schedules as such, he did point to the objective of the participation of the utility companies in the development of atomic power. He said:

"Electric utility companies have a long record of reducing the cost of their service to the public through the development of new methods and processes and improved efficiency of operations. The industry today employs every available means in order to continue the long-term trend for the benefit of our customers. To this end we believe that development of nuclear power is a logical extension of our continuing endeavor to provide electricity in abundance at the lowest possible price."

Thus it is evident that from the veiw of the electric utility companies the pace of the development of industrial atomic power is to be geared to the question of producing electricity at the lowest possible cost.

In this regard I would like to direct the attention of this committee to a letter to your chairman, dated February 20, 1957, from Mr. F. K. McCune, vice president and general manager, Atomic Products Division, General Electric Co. In discussing the economic question with respect to the development of atomic power, he states:

"Of primary importance is the present lack of economic incentive. Normally a business begins to grow rapidly when its products produce increased value for its customers. Presently there is much to do before atomic power is competitive in our normal markets; hence our customers are spending money on their projects rather than receiving increased value from them."

We are thus left with this picture. A representative of the utility companies states that their objective in the development of atomic power is to provide electricity at the lowest possible price. A representative of one of the largest equipment manufacturers in the field acknowledge the high costs of nuclear power and the present lack of economic incentive.

Moreover, in this same vein, Mr. Willis Gale, chairman of TAC Commonwealth Edison Co., is reported by a New York newspaper to have warned the bankers;

"Don't go overboard on atomic power for the short term, but be optimistic for the long term."

He also said that: "Everything considered, I do not disagree with those who believe that our atomic power program should be expanded beyond the ability of private industry to carry the entire cost."

The question then is: Can we, in the national interest, afford to wait? Can we leave the pace of the development of industrial atomic power geared to the utility companies whose objective is to produce electricity at the lowest possible costs, and to the manufacturers who realize the lack of economic incentive. I maintain that we cannot.

In concluding I would like to revert back to Mr. Lindseth's testimony. You were informed that 69 utility companies are participating in 14 reactor projects which are expected to have an electrical capacity of over 1,500,000 kilowatts and which will involve expenditures of over $400 million of investors' funds. I know that Mr. Lindseth does not want anyone to draw a mistaken impression from his remarks. But the 1,500,000 kilowatts and $400 million which he cited lose most of their apparent substance under close scrutiny. More than half of these 1,500,000 kilowatts are supported only by announcements or state-

ments of intention. For most of the remainder we have no firm assurances that the projects involved will ever be completed.

For example, the Ohio Valley group has announced plans which are included among the 14 projects referred to. It intends to formulate a proposal to the AEC to construct a small prototype reactor with an electrical output equivalent to about 13,000 kilowatts. If research and the prototype develop satisfactorily, it hopes to undertake well before 1962 plans for the construction and operation of a full-scale recator of up to 200,000 kilowatts of electric power.

If all goes well, we are informed, this larger plant will be constructed and in operation 7 or 8 years from now.

The picture you have been given of 1,500,000 kilowatts of industrial atomic power and $400 million, of private financing, could be labeled "If all goes well."

The CHAIRMAN. Thank you very much, Mr. Murray.

Senator ANDERSON. Could I just say I would like to put in the record an item from the Forum Memo of February 1957 along the same lines. I will just read the first paragraph and then the subsequent paragraph:

Last month the Atomic Industrial Forum completed the first opinion poll of its United States membership. The poll was undertaken in late December in an effort to identify those factors, if any, which may be inhibiting the growth and development of the atomic industry. The purpose of the poll was to assist the forum in arranging its program for 1957 and to produce information of value and interest to the atomic industry and the public.

I will skip the list how they picked them out. I want to read this much:

The leading obstacles listed by respondents were, in order:

1. Lack of economic incentive, which was mentioned 54 times and had 19 percent of the total weighted vote.

That is behind my question this morning about the rise in price on these things where they are rather expensive. Certainly it does provide a lack of economic incentive.

We had a record here one time for current at the Shippingport reactor, it seems like the figure was to start at something like 52 millions, finding with great good luck would come down to about 17 or 20 mills.

Now, with this increase in cost you are going to start it off at 75 mills and down to 30 mills and nobody thinks that is very competitive.

I just do not believe that private industry is going to rush madly into a chance to throw its money away while many of us have felt we would need to see some of these things develop.

The CHAIRMAN. Do you wish that included in the record?

Senator ANDERSON. I think we should include all of it in the record. I would like to include 5 or 6 of these first questions.

The CHAIRMAN. Without objection, it will be placed in the record at this point.

(The information referred to follows:)

EXCERPTS FROM A FORUM OPINION POLL

(Atomic Industrial Forum memo, February 1957)

* * * * * * *

Last month the Atomic Industrial Forum completed the first opinion poll of its United States membership. The poll was undertaken in late December in an effort to identify those factors, if any, which may be inhibiting the growth and development of the atomic industry. The purpose of the poll was

to assist the forum in arranging its program for 1957 and to produce information of value and interest to the atomic industry and the public.

* * * * * * *

The leading obstacles listed by respondents were in order: (1) Lack of economic incentive, which was mentioned 54 times and had 19 percent of the total weighted vote, (2) lack of insurance and/or indemnification, which was mentioned 38 times and had 11 percent of the total weighted vote, (3) secrecy and classification, which was mentioned 33 times and had 10 percent of the total weighted vote, (4) lack of trained manpower, which was mentioned 31 times and had 9 percent of the total weighted vote, and (5) Government administrative policies and practices, which was mentioned 32 times and also had approximately 9 percent of the total weighted vote.

The results varied significantly from group to group. For example, in first place among research institutions was "Government administrative policies and practices"; in first place among universities was "lack of trained manpower," and in second place among utilities was "high capital costs." In third place among utilities was "effect of the public versus private power controversy."

* * * * * * *

The CHAIRMAN. Does any other Commissioner have any statement he would care to make?

Dr. LIBBY. May I take a minute to speak on isotopes?

The CHAIRMAN. All right.

Senator ANDERSON. That is the best way to end this. That is the finest branch of the program.

Dr. LIBBY. Industrial isotopes savings are now about $400 million per year. I think about by 1956 or 1959 this will hit a billion dollars per year.

The CHAIRMAN. That is very encouraging.

Dr. LIBBY. I want to call the committee's attention to the fact that this is pretty fair interest rate on the total investment in our total weapons stockpile, our atomic power efforts, the engines for the atomic navy, all these things, which isotopes are very likely to pay for.

The CHAIRMAN. Do you have anything further, Mr. Strauss?

Mr. STRAUSS. No, thank you. We have enjoyed these hearings and are happy to have had the opportunity to appear.

The CHAIRMAN. Tomorrow we will hear industry. I would like to say to the Chairman of the Commission that next Tuesday morning at 10 o'clock we will hold a hearing on the so-called GAO report on the Yankee contract. I just wanted you to know of it.

Mr. STRAUSS. Thank you.

I think we have a letter before you now on that subject, and we will be prepared to respond to any questions.

The CHAIRMAN. We will recess until 10 o'clock tomorrow morning.

Mr. STRAUSS. Mr. Chairman, is the Tuesday morning hearing an open hearing?

The CHAIRMAN. It will be open.

(The statements referred to on p. 339 follow:)

EDISON ELECTRIC INSTITUTE,
TECHNICAL APPRAISAL TASK FORCE ON NUCLEAR POWER,
New York, N. Y., February 15, 1957.

Hon. CARL T. DURHAM,
Chairman, Joint Committee on Atomic Energy,
Congress of the United States, Washington, D. C.

DEAR CONGRESSMAN DURHAM: Thank you for your letter of January 18 informing the Technical Appraisal Task Force on Nuclear Power of the hearings to be held as required by section 202 of the Atomic Energy Act of 1954 and of the opportunity to present their views, either in person or in a statement for the record.

The task force has concluded that a brief written statement for the record would be most appropriate at this time. The present letter constitutes such a statement. Essentially it is a revision and extension of my letter of November 15, 1956, addressed to Senator Anderson.

The members of the task force who have accepted appointment and are serving are:

Robert F. Bacher, director, Norman Bridge Laboratory, California Institute of Technology.

James B. Black, board chairman, Pacific Gas & Electric Co.

Marion W. Boyer, director, Standard Oil Company of New Jersey.

Walker L. Cisler, president, the Detroit Edison Co.

James F. Fairman, vice president, Consolidated Edison Company of New York, Inc.

Augustus B. Kinzel, vice president, research, Union Carbide & Carbon Corp.

Herbert J. Scholz, board chairman, Southern Services, Inc.

Henry D. Smyth, chairman, Board of Scientific Engineering Research, Princeton University.

Philip Sporn, president, American Gas & Electric Co.

William Webster, executive vice president, New England Electric System.

Harry A. Winne, retired vice president, engineering, General Electric Co.

The assignment of the task force remains unchanged as follows:

1. To review continuously the progress of research and development, in the United States and elsewhere, of importance to the achievement of competitive nuclear power.

2. To study and report on all power reactor programs and projects.

3. To study and appraise the technical and economic factors and the results to be achieved by the design and construction at different times of prototype or full-scale nuclear powerplants.

4. To act as a liaison group with the members of any nuclear reactor evaluation group that may be set up on a national level.

This assignment is solely in the field of the technology and economics of nuclear power. The task force has been given complete freedom of action to handle the assignment as they deem best. Several outstanding nuclear consultants and consulting organizations have been called upon for assistance and one organization has been retained for an indefinite period. Conferences with manufacturers of nuclear reactors are being scheduled and of course liaison will be maintained with the reactor staff of the Atomic Energy Commission.

Thus far the work of the task force has been of an exploratory nature. Indeed, it appears likely that a large part of the effort will of necessity be exploratory. Facts must be sifted from opinions and must be verified before any conclusions may be reached and recommendations made.

At the moment, only one thing is clear, namely, that the technical and economic problems are so much more complex and the mass of information ranging from fact to speculation is so much greater than had been anticipated, that searches and studies must be pursued with vigor and diligence in order to find ways of attaining the four objectives cited above.

The findings of the task force will be presented from time to time to the board of directors of Edison Electric Institute, to whom the task force reports, and will be available to all who are actively interested in the development of nuclear power. These findings will of course be available to the joint committee and to the Atomic Energy Commission.

Sincerely yours,

JAMES F. FAIRMAN.

CONSOLIDATED EDISON COMPANY OF NEW YORK, INC.,
New York, N. Y., February 13, 1957.

Hon. CARL T. DURHAM,
Chairman, Joint Committee on Atomic Energy,
Washington, D. C.

DEAR MR. CHAIRMAN: This letter supplements our letter of January 30, 1957, to you, and has as its purpose a review of Consolidated Edison's atomic reactor program during the past year.

As you will recall, we first announced our intention to build and operate a reactor when I appeared before you committee in February 1955. Our application for licenses, filed shortly thereafter, first bore fruit in a construction permit issued by the Atomic Energy Commission on May 4, 1956.

During the past year we, together with our contractor, Babcock & Wilcox, and our consultant, Vitro Corp., have been steadily at work at the job of weighing our original design—through study and experimentation—to assure its ability to meet safety standards now or later established. I will summarize some of the major work that has been accomplished, mostly through our contractor.

In addition to study and experimentation, several concrete actions have been taken in the progress toward the construction of our reactor.

On May 29, 1956, Mr. J. W. Landis, assistant manager, atomic-energy division, Babcock & Wilcox Co., outlined to your committee the work his company was then doing.

Since that time, the Babcock & Wilcox Co. has continued its development, design, manufacturing, and procurement work. Approximately 100 full-time and 25 part-time scientific and technical personnel of the company are now engaged on the project.

Of particular interest are the following facts reported to us by Babcock & Wilcox:

1. The design and construction of a full-scale critical experiment has been completed. The AEC inspection was made on January 15, 1957, and an operating license is expected momentarily. As soon as the license is issued the critical experiment will get underway at once.

2. The Vitro Corporation of America has been engaged as the architect-engineer. Vitro has a substantial work force undertaking the layout and arrangement and detailed design work on the reactor service building, fuel handling and storage facilities, reactor shielding structure, excavations, foundations, and auxiliary reactor plant systems.

3. The detailed design has been completed and initial shop fabrication started on the reactor vessel and the four primary coolant steam generators.

4. Procurement has started on several other major components, i. e., primary coolant pumps and valves. During the next 6 months it is expected that the detailed design will have been completed and procurement started on the control rod drives, primary coolant piping, pressurizer, and the containment structure.

5. The Bailey Meter Co. has been engaged to supply all of the plant and nuclear instrumentation.

6. Measurements of the thorium resonance absorption integral, an important reactor physics core parameter, have been completed using the research reactor at Pennsylvania State University.

7. The scope of the supporting research and development program at the Babcock & Wilcox Co.'s central research laboratories at Alliance, Ohio, has been extended considerably and will be further extended during coming months.

8. The construction of a full-scale inpile loop for the irradiation of fuel materials is nearly complete. The installation and operation of this test facility is scheduled to be undertaken at the AEC's materials testing reactor next month.

9. The General Nuclear & Engineering Corp. has been engaged as a consultant on certain specific nuclear design and safety problems.

Our program is now in midcourse. We have reached the point where the results of study and experimentation are being reflected in the firm decisions expressed in the placing of orders for major components of the reactor. I will not pretend that these decisions have been easily made. Problems have arisen as I anticipated in my testimony before your committee in February 1955.

For example, certain data on radiation damage developed by Babcock & Wilcox led them to recommend a change in the fuel element from metallic thorium and uranium-zirconium alloy plates to uranium-thorium oxide rods. We have accepted the recommendation.

Another change has flowed from Babcock & Wilcox's continued examination of the possibility of a metal-water reaction. Some technical information indicates the possibility of such a reaction. Total available information on the subject, in the opinion of Babcock & Wilcox, is not sufficient to rule out the remote possibility of such a reaction. In order to provide maximum flexibility for the containment of such a reaction a single sphere design has been recommended. Again, we have accepted Babcock & Wilcox's recommendation, especially since it bears on the vital consideration of reactor safety.

Obviously, if these new data and decisions are to be incorporated in revised designs and construction orders we must expect some delay and substantial additional costs. Because of these design changes, the increase in materials cost and the designed increase in ultimate plant capability to 275,000 kilowatts, we now anticipate a total plant cost of about $70 million rather than $55 million.

As of February 1, 1957, Consolidated Edison has committed or spent approximately $16 million on its nuclear plant program. This total includes amounts paid to Babcock & Wilcox, fees to Vitro, the site-leveling contract (work at the site has now begun). purchase of nuclear material and contracts for conventional equipment.

Our relations with State and local authorities have continued to develop on a very satisfactory basis. We have kept the New York State Public Service Commission generally advised of our progress. In Westchester County—where the reactor is to be built—we have sponsored a series of meetings through local organizations to inform the public. Local authorities have cooperated fully. We have also had discussions with the New York State Labor Department on radiation hazards and have had an opportunity to comment on proposed State regulations. One of our officers has been appointed as a member of a State advisory commission on atomic energy established by Governor Harriman.

Most of our recent thinking is not yet reflected in formal documents submitted to the Atomic Energy Commission, although informal discussions have taken place. Within the very near future, however, we expect to file appropriate amendments to our application for licenses and supporting papers.

If you wish more detailed information on the matters covered in this letter statement, I shall be glad to supply it or, if appropriate, request our contractor, Babcock & Wilcox, to supply it.

In general, I believe our program is progressing quite satisfactorily. We are confident that we will meet the 1960 target date for completion of our nuclear plant.

Respectfully yours,

H. R. SEARING,
Chairman of the Board.

AMERICAN GAS & ELECTRIC SERVICE CORP.,
New York, N. Y., February 18, 1957.

Hon. CARL T. DURHAM,
Chairman, Joint Committee on Atomic Energy,
Congress of the United States, Washington, D. C.

DEAR MR. CHAIRMAN: A group of electric utility companies operating in the Ohio Valley and contiguous areas have for many years been cooperating in the power supply of that area. With this background and their common regional interests, it was natural that, in their individual efforts to improve the technology of producing electric energy, a large number of these companies should have joined together to discuss plans for the acquisition of knowledge and experience in the nuclear field.

As a result of these discussions, 12 electric utility companies completed an agreement last Friday and are now formulating plans to undertake jointly a program of nuclear reactor research and development which, we believe, will represent a significant advance in the technology and economics of utilizing nuclear fuel to produce commercial electric power.

The group proposes first to intensify discussions with the Atomic Energy Commission and manufacturers and to make an evaluation to determine which of several reactor types under consideration by the group should be developed. As described at a later point, we have already identified 3 concepts that we regard as particularly attractive for study, and possibly 1 or 2 others may commend themselves to us before we finally select the reactor to concentrate on. The study and evaluation phase of our work should be completed in the next few months. The group will then formulate a proposal to the AEC. The proposal would contemplate that the AEC participate in the project and share in its cost and benefits.

It is contemplated that our proposal will consist of the necessary preliminary research and construction thereafter by the group of a small prototype reactor having a heat output of about 50,000 kilowatts (equivalent to about 13,000 kilowatts electric power although in our present plans we have not decided that it would be worthwhile to add a turbine to the prototype). This, it is hoped to complete by 1961 but not later than 1962. Depending on the type selected, the overall program, including construction of the prototype, is estimated to cost from $15 million to $31 million.

If the research work and prototype develop satisfactorily, it is hoped to undertake well before 1962 the preparation of plans for the construction and operation of a full-scale reactor of up to 200,000 kilowatts of electric power. If all goes

well this plant would be constructed and in operation 7 to 8 years from now. The group's present plans, however, are limited to the initial phase of research and development and construction of the prototype.

The participating companies are:

American Gas & Electric Service Corp., New York (service organization of the American Gas & Electric System).

The Cleveland Electric Illuminating Co., Cleveland, Ohio.

Columbus & Southern Ohio Electric Co., Columbus, Ohio.

The Dayton Power & Light Co., Dayton, Ohio.

Indianapolis Power & Light Co., Indianapolis, Ind.

Louisville Gas & Electric Co., Louisville, Ky.

Monongahela Power Co., Fairmont, W. Va.; the Potomac Edison Co., Hagerstown, Md.; and West Penn Power Co., Greensburg, Pa., of the West Penn Electric System.

Ohio Edison Co., Akron, Ohio, and Pennsylvania Power Co., New Castle, Pa., of the Ohio Edison System.

Southern Indiana Gas & Electric Co., Evansville, Ind.

The three reactor types, all high-temperature designs, now under consideration are—

1. A graphite suspension reactor with ceramic fuel elements, proposed by the Babcock & Wilcox Co.;

2. A liquid-metal-cooled, natural uranium, heavy-water-moderated reactor, proposed by Nuclear Development Corporation of America; and

3. An advanced-type sodium-cooled, grahpite-moderated reactor with ceramic fuel elements, proposed by General Electric Co.

In formulating our plans our group has been influenced by the following philosophy: We believe that, important as capital costs are, nuclear fuel costs at least for a long time are not going to be negligible items. We have been impressed with the need to devote much more attention to each element entering into fuel cost, from the delivery of the ore to the final preparation of the fuel. Many of the companies in our group operate in the largest coal-producing area in the United States, the so-called eastern fuel province, and over a number of decades have developed a technology of using coal of the lowest quality burnable (therefore lowest cost) as a basis for bringing about improvements in their power-producing costs. We believe this same basic thinking should be introduced into atomic-fuel technology. After all, the amount of heat released in the fissioning of an atom or a gram of uranium 235 is independent of the fine quality of workmanship put in on the uranium metal before it is introduced as a fuel element.

At the same time, because of the importance of capital costs in determining the ultimate cost of nuclear power, we intend to stress improvement in thermal economy and the resulting reduction in the reactor size per kilowatt of power as one of the surest roads to lower capital cost. The experience of our group in building conventional plants has repeatedly shown the great contribution that can be made toward lowering of capital costs by reducing the amount of fuel required to generate a unit of electric energy. In its work the group will also seek to stress reactor concepts which do not have inherent limitations on temperatures and pressures. Our aim is to develop a project in which high temperatures and high pressures can be used so as to achieve economies in nuclear generation just as these characteristics have enabled us to promote advances in conventional power technology.

Because of our philosophy, the three reactor concepts which we shall be evaluating in our study of the next few months are particularly attractive. All three have this in common: They are concepts which lend themselves to high pressures and high temperatures; they are, therefore, concepts which make possible exploitation of high thermal efficiencies on the turbine end. And, as now conceived, they all offer possibilities of using the simplest kind of fuel elements by slight enrichment in two cases and with natural uranium in the other.

The time scale of our program, while apparently long, is in our judgment, and in the judgment of others, in line with the time scale of acquisition of knowledge in parallel technologies with which we are familiar; it is, in brief, not unduly drawn out, but is realistic. We realize, of course, that our plans do not represent the only way of proceeding to develop economical nuclear power. Indeed, there may be no "only" way, and it is necessary to pursue a considerable number of them. But the course we contemplate appears to our group to be the best way for us to contribute our share.

As our project moves forward, we will be glad to advise the Joint Committee of developments and, if the committee would like a representative or represent-

atives of this group to appear before it for that purpose at any subsequent hearings, we will be most happy to do so.

We are today sending a similar letter to the chairman of the Atomic Energy Commission, with whom we have been discussing this project.

Yours sincerely,

KENNETH C. LONG,
WALTER H. SAMMIS,
PHILIP SPORN,
EARLE S. THOMPSON,
Working Committee of the Group of Companies Indicated.
By PHILIP SPORN, *Chairman.*

AMERICAN FARM BUREAU FEDERATION,
Washington, D. C., February 1, 1957.

Hon. CARL T. DURHAM,
Chairman, Joint Committee on Atomic Energy,
Senate Office Building, Washington, D. C.

DEAR CONGRESSMAN DURHAM: Thank you very much for your letter of January 18 extending an invitation to the American Farm Bureau Federation to testify with respect to developments in and needs of the atomic-energy industry and suggested changes in the law believed necessary for maximum progress in this field.

Our interest in this question is from the standpoint of general policy. At our most recent annual meeting the elected voting delegates of the member State farm bureaus approved the following statement of policy:

"The production, transmission, and distribution of power, including the commerical production of electric power from atomic materials, should be primarily a function of private enterprise, either cooperative or noncooperative. The entry of the Federal Government into the power business should be restricted to those instances where adequate development cannot be had otherwise."

While a substantial degree of Government participation and coordination in research, promotional and development activity is necessary under the circumstances, it is our basic belief that maximum progress will be made if Government itself abstains from actually engaging in the commercial production of power. We do not believe the special problems associated with the production of power from nuclear material should be considered as a reason for the entry of the Federal Government into the commercial business of power production and distribution. It is our conviction that maximum progress will result if we leave the commercial aspects of the program to private enterprise. The entry of Government into the commercial production of power from atomic sources is likely to diffuse effort and responsibility to an extent that will, in the long run, serve as a deterrent to maximum and expeditious progress.

We note with interest your comment that "It is the committee's intention, as exemplified in the Atomic Energy Act of 1954, to encourage maximum private participation in the peacetime atomic energy program." We, of course, are in thorough accord with this concept, and recommend it continue to be the guiding principle for committee consideration.

We do not presume to be familiar with the technical problems involved such as those set forth in your letter and the attachment thereto. We do not, therefore, believe any purpose would be served by our appearing as a witness at the hearings scheduled by the Joint Committee. It will, however, be appreciated if you will incorporate this letter in the hearing record.

Very sincerely,

CHARLES B. SHUMAN, *President.*

STATEMENT FOR THE RECORD OF THE JOINT COMMITTEE ON ATOMIC ENERGY, IN CONNECTION WITH THE STATUTORY HEARINGS, FEBRUARY 19, 20, 21, 26, 27, AND 28, 1957

It has been the policy of the Joint Committee and of the Atomic Energy Commission to encourage private industry to participate in the development of nuclear energy, particularly in the power industry and in research. As a result of this encouragement, many organizations have accepted, at the request of the Atomic Energy Commission, fixed-price contracts for jobs which they were not well prepared to carry out. Some of these organizations have, in order to secure a creditable performance, incurred large losses which they cannot afford.

The simple basis of the matter, in my opinion, is that prices were quoted on too low a basis, due to lack of experience in the field.

I believe that an undue emphasis is being placed by Government procurement agencies to insist on fixed-price contracts under the present circumstances, where vendors have so little experience upon which to base firm prices without the serious danger of incurring crippling losses by reason of the highly technical excellence required in atomic-reactor materials and equipment. This insistence on fixed prices, even where much of the equipment is still highly developmental, requires either higher prices than would be otherwise justified with more experience or the danger of serious losses if an effort is made to bid on a more reasonable basis.

Actually the purchasing agencies for the Government are well protected against excessive profits, by reason of the renegotiation clauses in the various contracts, whereas the vendors are not protected except by high prices, and even that protection is doubtful. I feel very strongly that cost plus fixed fee of 10 percent before taxes should be encouraged in contracts covering known developmental types of equipment to afford reasonable protection to the vendors. Such contracts are and should be adequately policed against any excessive charges; but a provision of the nature outlined above would encourage industry to put forth greater efforts in the field of nuclear energy, whereas at present many of the contracts are serious gambles with no recourse whatever for the vendors.

With respect to another phase of this business, it is my opinion that our sales efforts abroad are still being handicapped by the slow release of classified information which is related only to the power reactors, and has nothing to do with weapons or the military effort. Current classification rules have made much information available for declassification. The procedures of declassification are, however, time-consuming and burdensome. I offer as a suggestion that it should be possible to declassify information by categories which has been put into the declassified areas to get away from the slow procedures which are now in effect.

E. W. MILLS,
President, Foster Wheeler Corp.

WOLVERINE ELECTRIC COOPERATIVE,
Big Rapids, Mich., February 5, 1957.

HON. CARL T. DURHAM,
Chairman, Joint Committee on Atomic Energy,
Congress of the United States, Washington, D. C.

DEAR MR. DURHAM: We appreciate your information in regards to the hearings before the Joint Committee on Atomic Energy that are scheduled for the latter part of February.

At this time we are deeply engaged in the final arrangements of contracts between the Atomic Energy Commission and Wolverine Electric Cooperative, Inc. for the design, development, construction, and operation of a (5 to 10 megawatts electrical) aqueous homogeneous reactor. It is our belief that nearly all of the terms of this proposed contract have been resolved and it is anticipated this project will go forward in the very near future.

The Wolverine power-reactor project is being developed jointly by the Atomic Energy Commission, Foster Wheeler Corp., Worthington Corp., the Rural Electrification Administration, and Wolverine Electric Cooperative, Inc., whereby each company involved is contributing a great deal of effort and financial assistance. It is our belief that a project of this nature will lead to better development of power-type reactors, whereby the complex problems will be resolved which will enable us to achieve our common goal whereby the United States will maintain leadership in the development of peaceful use of atomic energy. Therefore, we are encouraging more projects of this nature.

In the past we received splendid cooperation from the Atomic Energy Commission and with this continued cooperation we expect this project to continue and become a milestone in this development program. However, as you well know there are many problems to be solved, such as indemnity against reactor hazards, training of personnel, community education, etc.

We do not plan to appear before the committee at this time, however, this letter may be used as a statement for the records, if it is of any value to the committee.

Very truly yours,

WOLVERINE ELECTRIC COOPERATIVE,
JOHN N. KEEN, *Manager.*

METALS & CONTROLS CORP.,
NUCLEAR PRODUCTS DIVISION,
February 12, 1957.

Hon. CARL T. DURHAM,
Chairman of Joint Committee on Atomic Energy,
Congress of the United States, Washington, D. C.

SIR: We are pleased to have the opportunity presented by your letter of January 18, 1957, to go on record as to our views concerning the progress of the role of private industry in the atomic-energy program.

As you know, we have been fabricating nuclear fuel as a private industrial organization since 1952. Nearly all of our products have been for the Atomic Energy Commission under direct contract as nonlicensed fabricators, and we have received excellent cooperation from the Commission throughout these activities. However, we find that, under present regulations, there is need of clarification of Commission intent as to the practices to be followed in doing work for the Commission on a license basis. Because of the lack of clarity as to intent, we now operate in a dual status, that is, nonlicensed fabricators for Commission work, and licensed fabricators for private work. However, many difficulties are presented when a fuel element fabricator tries to operate under such a dual system.

A comparison between our regular commercial business and our nuclear business will help to make this clear: In our commercial business as to a given product line, regardless of whether the Government or a private firm is the customer, a common inventory, common accounting system, common manufacturing facilities, and common billing practice, etc., are utilized with resulting savings to the customer. In such cases, for example, the cost of scrap recovery, insurance, inventory control, etc., are cost factors used in determining the price charged.

A good illustration of the latter is our procedure in the making and selling of gold plate, a business of long standing with us. Here, we purchase gold bullion by permission of the Government, and then process this material and certain noncontrolled base metals into finished gold plate. Our price to the customer, Government or private, includes all of the factors listed above and includes the cost of scrap recovery.

We believe it is to the best interests of all concerned to operate in a similar manner in our fuel element fabricating business. However, even though the present regulations, as worded, seem reasonable, nevertheless, we find that in trying to put these regulations into practice, there are many areas where clarification is needed as to details, in order to enable us to determine whether or not it is economically sound for us to operate as a licensed fabricator for Commission work.

Amplifying the above statement, examples of some of the broad areas in which policy questions need to be answered are as follows:

1. *Allowable costs.*—Since it is quite likely that the bulk of fuel element fabrication will be for the Commission for some time to come, we need to know whether the new and unusual types of cost encountered will, in the future, be allowable under the Commission cost-accounting procedures. Specific examples are: Costs of insurance, inventory, and scrap recovery.

2. *Scrap recovery.*—The metallurgical recycle of clear scrap generated during fuel element fabrication is a vital part of the effective utilization of special nuclear material, but nonreusable scrap material will also remain which must be chemically recovered. To date, we have been unable to find private facilities for the economical recovery of such material, and unable to ascertain the Commission's policy regarding scrap recovery and the charges to be made therefor (or even whether or not the Commission will process licensed scrap). This lack of certainty regarding scrap recovery is a deterrent to affective progress on the part of completely private licensed operations for fuel element fabrication.

3. *Indemnity.*—It is noted that the questions of indemnity and insurance will be covered in detail at later hearings, but we emphasize here that lack of a consistent policy to date on the part of the Government stands as a serious deterrent to the investment of private capital in the nuclear-energy business. While we believe that the sense of moral responsibility would cause the Government to assume the financial burden of a major nuclear incident, nevertheless we also believe that in the best interest of certainty all doubts and ambiguities on this point should be cleared up by the Government's spelling out clearly its full assumption of this responsibility.

While there are many details under the above discussion which we are not attempting to cover here we would like to suggest that the utilization by the Commission itself of licensed procedures for its own procurement activities, as compared to the control which the Commission exercises (based on those same license procedures) over strictly private industrial operations, be unified. We believe considerable progress has been made in the implementing of the 1954 act, but that there are some areas in which clarification as to overriding policies will result in much greater progress for the entire program.

Sincerely,

J. OTTMAR,
Vice President and General Manager.

GENERAL PUBLIC UTILITIES CORP.,
New York, N. Y., February 11, 1957.

Hon. CARL T. DURHAM,
Chairman, Congressional Joint Committee on Atomic Energy,
Washington, D. C.

DEAR CONGRESSMAN DURHAM: This acknowledges with thanks your letter of January 18 addressed to Mr. Tegen, who has referred it to me, inviting us to appear or submit a statement at the statutory hearings in February on the "development, growth, and state of the atomic-energy industry." We do not desire to appear at the hearings and in lieu thereof submit this letter-statement.

As we advised your committee last year in a letter dated March 2, 1956, to Senator Anderson, GPU has for some time been actively considering the technical and economic feasibility of installing a nuclear powerplant in the Philippines on the system of our operating subsidiary, Manila Electric Co. Our studies progressed to the point where invitations were issued early last year asking for proposals from 4 of the major equipment manufacturers on a nuclear plant with an electrical capacity of 60,000 kilowatts. Proposals were received from two of the manufacturers in the summer of 1956, based on a pressurized water type of reactor. Since last summer we have been hard at work, with the help of consulting electrical and nuclear engineers, in evaluating the proposals which we received.

In our evaluation task we have had to grapple with a number of problems. Both of the proposals we received were on a basic price basis, subject to normal price escalation, on certain items of equipment, including the reactor itself, and on the fabrication of the initial reactor core. But a good many items of equipment, as well as other costs, representing over 50 percent of total installed costs of the powerplant, were not included in the proposals. It has, therefore, been necessary for our consulting engineers, after preparing preliminary plant layouts, to go over carefully with the manufacturers all of the items included in the proposals and to prepare specifications and cost estimates on items not included, as well as costs of installation at the plant site selected and already owned by Manila Electric Co., in order to arrive at an estimate of the capital cost of the plant.

The problem of evaluating fuel costs has been even more difficult. While the proposals we received included fabrication of the initial reactor core, they did not include many of the cold processing and other steps required in the preparation of fuel elements or any of the steps necessary for reprocessing spent fuel elements. It has therefore been necessary for us to obtain cost estimates, for example, on the initial conversion of UF_6, obtained from AEC, to uranium oxide and delivery of the material to the fabricator in required form, and to estimate costs of scrap recovery and processing losses. It has also been necessary for us to obtain cost estimates on the several steps required for processing irradiated fuel elements and recovery of the fissionable materials. In all of this we have been handicapped by the lack of commercial experience with the operations and uncertainty as to where such processing work can or will be done, in view of the present lack of private facilities capable of handling irradiated fuel. As an item of possible interest to your committee, I am enclosing a copy of a flow diagram which we have used in our work and which shows each of the important steps in the fuel cycle with which we have had to be concerned.

We expect to complete the first stage of our evaluation of the proposals within the next few months, and would be willing at that time, if desired, to make a

report to your committee on the results of our work. We believe that we can then comment most usefully on the topics listed in the appendix to your letter of January 18 in relation to our specific project and that we should therefore defer until the time of our report comments on these items. As to these topics, it should be apparent from the steps we have sketched above in our evaluation work on this project, our approach has been primarily from the standpoint of an operating electric utility company.

Sincerely,

E. W. MOKEHOUSE, *Vice President.*

KOPPERS CO., INC.,
Pittsburgh, Pa., February 4, 1957.

Hon. CARL T. DURHAM,
Chairman, Joint Committee on Atomic Energy,
Congress of the United States, Washington, D. C.

DEAR MR. DURHAM: I wish to thank you for your letter of January 18 advising us of the forthcoming Joint Committee hearings on the development, growth, and state of the atomic-energy industry.

We are pleased to hear that you intend to devote special attention to fuel fabrication and reprocessing, waste disposal, and reactor types other than for electric power. In our opinion, satisfactory solutions to the problems of spent fuel processing and ultimate disposal of radioactive wastes are mandatory for the continued development of the nuclear industry. Some of our preliminary studies have indicated potential applications in chemical and metallurgical processing for atomic reactors capable of supplying heat energy in the 2,000 to 3,500° F. range, but a great deal of development work will have to be carried out before attainment of specific goals can be expected.

We appreciate your kind offer for Koppers to present its views, but believe that the Joint Committee is already cognizant of any matter which we might discuss. Our company will, of course, be more than happy to provide any specific information which you or your associates may wish to request.

Yours very truly,

W. F. MUNNIKHUYSEN,
Chairman of the Board.

STATEMENT OF DR. JOHN J. GREBE, DIRECTOR, NUCLEAR AND BASIC RESEARCH, THE DOW CHEMICAL CO.

WASTE DISPOSAL

One major problem that has often been referred to as a limitation on the growth of the utilization of nuclear energy is waste disposal. We feel it is important for all to know that this disposal problem has been taken care of by new technology recently demonstrated.

There are very few areas in the country where one has to go long distances to get to a sedimentary rock formation containing clays, shales, or other impermeable strata. Therefore, after the fission products have been used industrially for the many purposes being developed and final disposition of the wastes is to be made, we now have assurance that no problem of disposal can be too large to be handled. Solid impermeable shale beds have recently been fractured hydraulically and large quantities of sand, nearly a million pounds, have been pumped into such fractures at depths decidedly below any possible usable water-bearing strata, even several thousand feet below sea level. Under these conditions, it is no longer necessary to worry about whether one can get by disposing of wastes in oceans or even in clay pits, cavities in salt domes, and the like, for it has been demonstrated that the space can be provided in solid clay or shale deposits by merely using sufficient pressure to lift the earth above the point of injection.

The whole technology of underground disposal initiated by fracturing formations in 1930 has been advanced very rapidly in the last 10 years. A number of States followed the lead of Michigan in supporting this work through the conservation departments. Kansas, Oklahoma, Illinois, and Texas are well established in this method. With 21 years of continuous experience in Michigan, one should consider this process to be of age.

Many organizations would prefer to have work of this kind done for them by contract. There are many locations also where disposal should best be taken care of as a joint venture for a number of waste-producing industries. For

instance, Dowell, Inc., a wholly owned subsidiary of the Dow Chemical Co., is equipped today to take the responsibility for installing and operating such installations for others. Dowell is an established organization with more than 100 service centers located throughout the United States, including almost all of the major ports and industrial centers. Hundreds of its technical men have concentrated in this field for many years and highly specialized equipment has been developed for such fracturing and disposal operations.

With the advent of radioactive wastes, underground disposal has become even more important than ever before.

After all, the earth is a tremendously large nuclear reactor which provides half the heat of the earth's interior. The other half is provided by the effect of the accumulated fission products, such as potassium 40. The trivial amount of radiation from all of our nuclear-reactor wastes could not be noticed if added to the earth's underground heat sources.

Almost any form of material can be so disposed. While disposal into igneous rock is difficult, we do dispose of large quantities of material into the wells that lead into sedimentary rock. Almost all formations permit fracturing to occur if one applies a high enough pressure for a long enough time. The rock first expands outward, producing vertical cracks, and then permits horizontal fracturing whenever enough high-pressure fluid gets between any two layers to raise the earth above it. We make room for hundreds of thousands of pounds of sand by this technique every day in conjunction with Dowell operations for increasing the permeability of oil- and gas-containing formations. One can make room for almost any kind of a solid by this method. As a rule the pressure required is equal to 1 pound per square inch times the depth in feet to make the initial break and about two-thirds that much to maintain the flow in.

In general, sedimentary rock below the sea level is not likely to contaminate useful water. Old abandoned oil or gas fields should be considered the favored disposal spots, since these have been proven through the ages to be tight enough to hold even gas and oil.

The most severe condition likely to be met is that some waste may require the simultaneous introduction of cement to immobilize the wastes underground. In general, a mixture of clay and most wastes will hold active ions in place by the ion-exchange properties of clay. This was demonstrated by Dr. L. A. Matheson and the writer on Hanford reactor wastes, in 1948.

This whole process is no more mysterious than pumping sand, gravel, and cement under pavements to lift them back up to the proper level.

PIONEER SERVICE & ENGINEERING CO.,
Chicago, Ill., February 8, 1957.

HON. CARL T. DURHAM,
Chairman, Joint Committee on Atomic Energy,
The Capitol, Washington, D. C.

DEAR CONGRESSMAN DURHAM: Thank you for your letter of January 18 informing me of the tentative schedule of the statutory hearings of the Joint Committee on Atomic Energy. We appreciate the opportunity which you offer us for presenting our views to the committee.

The only statement we would like to make at this time is to speak in favor of the bills which have been introduced by Senator Anderson and Congressman Price with respect to liability insurance. We believe that such legislation would be in the public interest since it would assure the public generally that adequate provision would be made for their protection. This in turn would be helpful in expediting the civilian atomic power program. Although it now appears that substantial amounts of insurance coverage will be obtainable from private sources, the program would be greatly expedited if the general public had the assurances that proposed legislation would give.

While the information will probably come to the attention of your committee through other sources, I wish to take this occasion of telling you of an announcement made today by a group of electric utilities that they have plans for the construction of a full-scale atomic powerplant of advanced design. We do not presume to be the spokesman for the group although we have been active in the planning and negotiation stages and expect to act as architect-engineers for the project. The announcement of this project culminates discussions and negotiations which have been carried on for several months, and by way of preliminary information for the committee we are enclosing a copy of

the press release by Northern States Power Co., which will give you the highlights of the project and the names of the participating companies.

Respectfully yours,

FRED C. KELLOGG, *President.*

THE ATOMIC LAW INSTITUTE,
Washington, D. C., January 29, 1957.

HON. CARL T. DURHAM,
Chairman, Joint Committee on Atomic Energy,
The Capitol, Washington, D. C.

DEAR CONGRESSMAN DURHAM: This is in response to your kind invitation of January 18 for an expression of views on atomic energy matters for consideration at the coming statutory hearings.

Since resigning from the AEC a year ago, my special interest in atomic energy has centered on the one problem which is common to all participants in this new technology, viz, the radiation hazard.

There is a distinguishing feature about this novel industrial hazard which warrants the attention of the Joint Committee. Should business fail to observe the rules of exposure tolerance intended to govern their activities in this industry, the "chicken," or consequences of such failure, may not come home to roost for many years. Thus, there is no self-policing incentive for the licensees of radiation sources to exercise the high degree of care which the potential hazards of overexposures warrant.

There is some misconception that the radiation hazard is of congressional concern only when released through incidents in the catastrophe range. I believe the chronic low-dose exposures which will attend all peacetime applications of atomic energy present problems of even greater practical significance since such exposures are the inescapable consequence of day-to-day routine operations in all areas of this technology. Yet no insurance or indemnity program proposed to date would afford employees or third parties an effective remedy for any negligence of management in this area. This is so because the procedural and substantive limitations which will govern those abused by any such misconduct are not adequate to cope with the peculiar characteristics of radiation and its biological effects. Nor can we reasonably expect those laws to be changed without some struggle.

To stimulate the rapid expansion of licensed operations without providing some built-in incentive for assuring adherence to the permissible levels of exposure would be an unbalanced approach toward the beneficial objectives of atomic energy which the Joint Committee seeks to attain.

Considerable study of the problem has convinced me that the sanctions of license revocation or suspension by the AEC for any careless abuse of that agency's prescribed exposure limits is not the answer to this need. Only a system of monetary fine or penalty assessment commensurate with the degree of overexposure involved will assure the scrupulous observance of the standards which have been found essential for individual and public protection against the excessive release of ionizing radiation. Obviously, the need for prescribing limits in the first place implies an equal public interest in the effective enforcement of those limits when established. Fairness to industry requires an early definition of its ultimate financial obligations in this area before undertaking any large-scale radiation work.

Should you wish a more detailed treatment of this subject, there is available to you in the committee files my analysis of the problem, published by the Whaley-Eaton Service on October 1, 1956.

Thank you for the opportunity which you have afforded me to bring this matter to your attention.

Sincerely yours,

BIGELOW BOYSEN, *Director.*

STATEMENT BY WALKER L. CISLER, PRESIDENT, POWER REACTOR DEVELOPMENT CO.

This statement by Power Reactor Development Co. (PRDC) is submitted to the Joint Committee of Congress on Atomic Energy for inclusion in the record of the section 202 hearings of 1957 session. PRDC is a nonprofit corporation organized under the laws of the State of Michigan and has 21 members as listed in exhibit I. It is engaged in a project to design, build, own, and operate a developmental fast

neutron power breeder reactor having an electrical capacity of 100,000 kilowatts or more.

This project, which we believe is one of the most advanced atomic power projects in the United States, was undertaken in response to the power demonstration reactor program of the United States Atomic Energy Commission. The reactor is a part of the Enrico Fermi atomic powerplant which is now being constructed at Lagoona Beach, a site on the shore of Lake Erie in Monroe County, Mich.

Construction of the reactor is proceeding under a provisional construction permit issued to PRDC by the Atomic Energy Commission (AEC) on August 4, 1956. Foundations for the reactor containment building are essentially complete and erection of the building will begin in March.

Coincident with, and a part of such construction, important programs of research and development work are being carried on by AEC, by PRDC and by Atomic Power Development Associates, Inc. (APDA), a nonprofit New York membership corporation, the members of which are set forth in exhibit II.

NATURE OF PRDC PROJECT

The project of PRDC originated 6 years ago when the Detroit Edison Co. and the Dow Chemical Co. jointly entered into a study agreement with the AEC to conduct research looking to the feasibility of generating electricity by the use of fissionable materials. After approximately 4 years of study by these companies and others which joined the group, APDA was organized and has continued the work previously conducted by the study group. APDA has performed extensive research and development in the fast breeder reactor field, the results of which have been available to PRDC and are generally available.

PRDC was organized to design, construct, own, and operate a fast neutron breeder reactor for what is known as the Enrico Fermi atomic powerplant. The reactor part of this plant together with the steam generators and other related equipment, which is now under construction, will be owned and operated by PRDC.

The Detroit Edison Co. will build, own, and operate the conventional steam turbine generator facilities adjacent to the reactor. It will buy the steam produced by the reactor, utilize it in the turbine-generator and distribute the electricity in its present electric power system. Contracts providing for the construction of the electric generating facilities to cost about $14 million and the purchase of steam by Detroit Edison have been negotiated and signed.

APDA is continuing to carry on research and development work. Included in the work being performed by APDA is the construction and operation of test devices and equipment which include several full-size components of the PRDC reactor. These components are now being manufactured and upon completion of the tests it is anticipated that many of the test components can be employed directly in the reactor of PRDC.

A contract between PRDC and APDA provides for performance of research and developmental activities by APDA and PRDC and includes a provision regarding transfer of test devices and equipment to PRDC. The information and know-how acquired in connection with the entire fast neutron breeder reactor project will be generally available subject to such requirements as the AEC may impose and no exclusive benefit is sought or will be obtained by the companies supporting the project.

FINANCING CONSTRUCTION OF PRDC REACTOR

The total estimated cost of the reactor portion of the plant to be built by PRDC is $43,216,000. Of this, $4 million in research will be provided in kind to PRDC by APDA, and it is estimated that PRDC will save the sum of $3 million in connection with the transfer to it by APDA of components used in the tests referred to below. The balance, or $36,216,000, is to be provided by contributions to PRDC by its members and their subsidiary companies and by borrowings. The sum of $23,540,000 has now been committed to PRDC and a loan agreement has been executed with certain banks acting as trustees of pension funds under and pursuant to which the sum of $15 million will be made available to PRDC, so that at present the sum of $38,540,000 has been committed to meet the cash requirement of $36,216,000. The contribution commitments to PRDC, which amount to $23,540,000 are unconditional. All approvals of local or Federal regulatory agencies which are required have been received. Exhibit III contains the names of the contributors and the amounts pledged.

The loan is to be made to PRDC is to be secured by guaranties to be executed by several of the utility companies. All such companies have agreed to execute the guaranty, subject to approval of local or Federal regulatory agencies having jurisdiction. Applications for such approvals as are necessary are on file and approvals in a number of instances have actually been received. Exhibit IV sets forth the companies guaranteeing the loan.

Late in 1956 PRDC applied to the Securities and Exchange Commission for an order under section 2 (a) (3) of the Public Utility Holding Company Act to the effect that PRDC was not an electric utility. A public hearing was held on such application on December 18, 1956, and the Securities and Exchange Commission has issued an order to the effect that PRDC is not an electric utility. Its members, therefore, are not subject to the Public Utility Holding Company Act by reason of participation in the PRDC project.

Applications for rulings with respect to the tax status of PRDC are pending in the Internal Revenue Service. Nevertheless, PRDC has proceeded with its project and its contributors have firmly committed themselves to their contributions to PRDC. PRDC and its members have taken this step in the absence of requested action, which PRDC believes to be entirely reasonable, because of the extreme importance of getting on with the job of developing peaceful applications for atomic energy. Both the management and members of PRDC felt that the progress of the extremely important project of the company should not be deferred during the determination of the status of the company and its contributors for purposes of Federal income tax or under the Public Utility Holding Company Act.

We are pleased that the Congress will during this session consider legislation recently introduced by Senator Anderson to provide insurance for the public in excess of that commercially available and we feel that enactment of such legislation is important to continued development in the field of atomic energy.

STATUS OF ENGINEERING, CONSTRUCTION, RESEARCH, AND DEVELOPMENT

The PRDC project in all of its phases is going forward satisfactorily and we are encouraged by our progress in this new field. To date PRDC has expended in connection with this project approximately $750,000 and has other commitments which exceed $1,500,000. Additional commitments are to be made shortly.

Architect-engineers

On April 27, 1956, PRDC selected Commonwealth Associates, Inc., of Jackson, Mich., as architect-engineer for the project. Commonwealth Associates immediately made site development studies and since then have been engaged in preparing plot plans, foundation designs, and detailed layouts for buildings, components and piping, and electrical systems. In addition, Commonwealth Associates have prepared cost estimates and are preparing on a continuing basis, schedules for the design, purchase, fabrication, and delivery of reactor components and construction materials to coordinate this work with construction schedules. The architect-engineering phase of the work is well ahead of requirements.

Construction

PRDC, on September 1, 1956, employed United Engineers & Constructors, Inc., of Philadelphia, Pa., as construction engineer for the project. Shortly after granting of the construction permit on August 4, 1956, United Engineers began supervision of the work at the construction site. Grading and filling of the site and the excavation for the reactor containment building have been completed. Erection of foundations for the reactor containment building is now 90 percent complete.

The reactor containment building has been ordered from the Chicago Bridge & Iron Co. That company has obtained all of the steel and is presently fabricating the necessary steel plates. In March 1957, the fabricated plates will be shipped to the construction site and erection will commence. The fabrication of the plates is proceeding on schedule and we look forward to beginning erection on schedule.

Presently the railroad siding to the construction site is in the process of construction and will be completed in time to facilitate delivery of the steel for the reactor containment building. Power supply lines have been erected to the construction site; potable water and sewage facilities are scheduled for installation this year.

The principal crane for the reactor installation—a 250-ton rotating crane—has been ordered from the Whiting Corp. and is now being manufactured, so that it will be available for installation simultaneously with the erection of the reactor containment building.

Research and development

It should be pointed out that the construction and research and development programs for this project are no different from those employed by other reactor development projects. The work is proceeding simultaneously on research and development, design, and construction.

The general parameters of the reactor were well established through extensive research and development work in advance of any decision to undertake the project. Several alternative solutions were possible for all points where definite decisions had not been reached.

Having made the decision to proceed with the project and established an anticipated completion date, it was then possible to establish interim dates when specific decisions must be reached. The necessary research and development programs were then undertaken to provide the required information at the necessary date.

In the meantime it is possible to proceed with the design and construction of the major parts of the reactor plant without waiting for final decision on component details.

PRDC now has active research and engineering contracts with Nuclear Metals, Inc., General Nuclear Engineering Corp., the University of Michigan, and consultants on the faculty of Cornell University, for the study of nuclear and mechanical design characteristics of components of the reactor plant, including, among others, specific studies on the fuel design. PRDC is also presently negotiating with several highly competent organizations for the performance of additional research and engineering work in connection with various aspects of components of the reactor plant, which will include studies of control systems and reactor physics.

As of December 31, 1956, APDA had expended in excess of $9 million in connection with research and development activities which have been principally devoted to work on the fast neutron breeder reactor. The information from the research and development activities of APDA is made available to PRDC on a current basis. Areas to which APDA is presently devoting attention include studies on fuel element design, shielding, mechanical handling systems, the coolant system—including studies of the sodium handling system, pumps and heat exchangers. Specific tests are being conducted by APDA on various fuel element samples which have been and are presently being irradiated, and upon which radiochemical analyses are being made.

The APDA program also includes the acquisition and erection of various test devices and equipment, all of which are now on order. Included among such devices and equipment are several full-size components of the reactor. These items will be erected at the construction site and extensive mechanical but nonnuclear tests and studies will be conducted during a 1-year test period. After testing is completed, all full-size components which prove to be acceptable will be used in the reactor itself.

In addition to the research, development, and engineering programs of PRDC and APDA, valuable information has been and is being obtained from the work being done at AEC laboratories in the fast reactor field. We look forward to continued coordination of our fast reactor program with that of the AEC and to the conduct of research and development work by the AEC under the power demonstration reactor program.

PUBLIC HEARINGS BEFORE THE ATOMIC ENERGY COMMISSION

As noted heretofore, the AEC on August 4, 1956, issued to PRDC a provisional construction permit under which PRDC has been proceeding with construction of the reactor plant. On August 31, 1956, several individuals and labor unions filed petitions to intervene in the licensing proceedings before the AEC. The petitions to intervene were allowed and a public hearing ordered on certain issues relating to the regulations of the AEC covering the issuance of licenses and construction permits, which issues were set forth in an order issued by the AEC on October 8, 1956. The hearings are well along and PRDC witnesses have already testified. Since the AEC is considering the issue of safety of fast breeder reactors in the pending proceedings, we do not feel it appropriate for us to comment on this important matter in this statement.

It is worthwhile to note that by coincidental programs of construction and research and development, a marked saving in time can be achieved in the development and operation of a large developmental power breeder reactor and that the only risk taken in connection with proceeding along such a course is that of a possible loss of a portion of the investment in construction. The PRDC management is convinced that the reactor as presently designed will be safe. If, however, further research points to changes in design for safety reasons, those changes will be made and even if of a major nature such changes can be made at relatively small cost compared with the total anticipated expenditure of over $40 million.

PRDC and its member companies appreciate the opportunity to pursue the project which they have chosen as their part in the development of peaceful applications for atomic energy and are confident that the work being performed will be of great importance to the people, Government, and industry of the United States.

Respectfully submitted.

POWER REACTOR DEVELOPMENT CO.
By: WALKER L. CISLER, *President.*

EXHIBIT I

MEMBERS OF POWER REACTOR DEVELOPMENT CO.

Allis-Chalmers Manufacturing Co., Milwaukee, Wis.
The Babcock & Wilcox Co., New York, N. Y.
Burroughs Corp., Detroit, Mich.
Central Hudson Gas & Electric Corp., Poughkeepsie, N. Y.
The Cincinnati Gas & Electric Co., Cincinnati, Ohio
Columbus & Southern Ohio Electric Co., Columbus, Ohio
Combustion Engineering, Inc., New York, N. Y.
Consumers Power Co., Jackson, Mich.
Delaware Power & Light Co., Wilmington, Del.
The Detroit Edison Co., Detroit, Mich.
Fruehauf Trailer Co., Detroit, Mich.
Holley Carburetor Co., Van Dyke, Mich.
Iowa-Illinois Gas & Electric Co., Davenport, Iowa.
Long Island Lighting Co., Mineola, N. Y.
Philadelphia Electric Co., Philadelphia, Pa.
Potomac Electric Power Co., Washington, D. C.
Rochester Gas & Electric Corp., Rochester, N. Y.
Southern Services, Inc., Birmingham, Ala.
Representative of:
The Southern Co., Birmingham, Ala.
Alabama Power Co., Birmingham, Ala.
Georgia Power Co., Atlanta Ga.
Gulf Power Co., Pensacola, Fla.
Mississippi Power Co., Gulfport, Miss.
The Toledo Edison Co., Toledo, Ohio
Westinghouse Electric Corp., Pittsburgh, Pa.
Wisconsin Electric Power Co., Milwaukee, Wis.

EXHIBIT II

MEMBERS OF ATOMIC POWER DEVELOPMENT ASSOCIATES, INC.

Alabama Power Co., Birmingham, Ala.
Allis-Chalmers Manufacturing Co., Milwaukee, Wis.
Atlantic City Electric Co., Atlantic City, N. J.
The Babcock & Wilcox Co., New York, N. Y.
Baltimore Gas & Electric Co., Baltimore, Md.
Bendix Aviation Corp., Detroit, Mich.
Boston Edison Co.. Boston. Mass.
Central Hudson Gas & Electric Corp., Poughkeepsie, N. Y.
The Cincinnati Gas & Electric Co., Cincinnati, Ohio.
The Cleveland Electric Illuminating Co., Cleveland, Ohio.
Commonwealth Associates, Inc., Jackson, Mich.
The Connecticut Light & Power Co., Hartford, Conn.
Consolidated Edison Company of New York, Inc., New York, N. Y.
Consumers Power Co., Jackson, Mich.
Delaware Power & Light Co., Wilmington, Del.
The Detroit Edison Co., Detroit, Mich.
Ford Motor Co., Dearborn, Mich.
General Motors Corp., Warren, Mich.
General Public Utilities Corp., New York, N. Y.
Georgia Power Co., Atlanta, Ga.
Gulf Power Co., Pensacola, Fla.

EXHIBIT II—Continued

MEMBERS OF ATOMIC POWER DEVELOPMENT ASSOCIATES, INC.—Continued

The Hartford Electric Light Co., Hartford, Conn.
Indianapolis Power & Light Co., Indianapolis, Ind.
Jackson & Moreland, Inc., Boston, Mass.
Jersey Central Power & Light Co., Asbury Park, N. J.
Leeds & Northrup Co., Philadelphia, Pa.
Long Island Lighting Co., Mineola, N. Y.
Metropolitan Edison, Co., Reading, Pa.
Mississippi Power Co., Gulfport, Miss.
New England Power Co., Boston, Mass.
NEGA Service Corp., Cambridge, Mass.
New Jersey Power & Light Co., Dover, N. J.
New York State Electric & Gas Corp., Binghamton, N. Y.
Niagara Mohawk Power Corp., Buffalo, N. Y.
Pennsylvania Electric Co., Johnstown, Pa.
Philadelphia Electric Co., Philadelphia, Pa.
Pittsburgh Consolidation Coal Co., Pittsburgh, Pa.
Potomac Electric Power Co., Washington, D. C.
Public Service Electric & Gas Co., Newark, N. J.
Rochester Gas & Electric Corp., Rochester, N. Y.
Southern Services, Inc.. Birmingham, Ala.
Toledo Edison Co., Toledo, Ohio
United Engineers & Constructors, Inc., Philadelphia, Pa.
Vitro Corporation of America, New York, N. Y.
Wisconsin Electric Power Co., Milwaukee, Wis.
Wisconsin Power & Light Co., Madison, Wis.

EXHIBIT III

Power Reactor Development Co.—Contributors and amounts pledged

Alabama Power Co	$800,000
Allis-Chalmers Manufacturing Co	500,000
The Babcock & Wilcox Co	1,000,000
Burroughs Corp	250,000
Central Hudson Gas & Electric Corp	200,000
The Cincinnati Gas & Electric Co	250,000
Columbus & Southern Ohio Electric Co	250,000
Combustion Engineering, Inc	1,000,000
Consumers Power Co	2,500,000
Delaware Power & Light Co	300,000
The Detroit Edison Co	8,750,000
Georgia Power Co	80,000
Gulf Power Co	200,000
Holley Carburetor Co	250,000
Iowa-Illinois Gas & Electric Co	120,000
Long Island Lighting Co	620,000
Mississippi Power Co	200,000
Philadelphia Electric Co	2,500,000
Potomac Electric Power Co	800,000
Rochester Gas & Electric Corp	450,000
The Toledo Edison Co	500,000
Westinghouse Electric Corp	1,000,000
Wisconsin Electric Power Co	300,000
Total	23,540,000

EXHIBIT IV

POWER REACTOR DEVELOPMENT CO.

Name of loan guarantor

Central Hudson Gas & Electric Corp., Poughkeepsie, N. Y.
The Cincinnati Gas & Electric Co., Cincinnati, Ohio
Columbus & Southern Ohio Electric Co., Columbus, Ohio
Consumers Power Co., Jackson, Mich.
Delaware Power & Light Co., Wilmington, Del.
The Detroit Edison Co., Detroit, Mich.
Iowa-Illinois Gas & Electric Co., Davenport, Iowa
Long Island Lighting Co., Mineola, N. Y.
Philadelphia Electric Co., Philadelphia, Pa.
Potomac Electric Power Co., Washington, D. C.
Rochester Gas & Electric Corp., Rochester, N. Y.
The Southern Co., Birmingham, Ala.
Wisconsin Electric Power Co., Milwaukee, Wis.

SPENCER CHEMICAL CO.,
Kansas City, Mo., February 15, 1957.

Hon. CARL T. DURHAM,
Chairman, Joint Committee on Atomic Energy,
House Office Building, Washington, D. C.

DEAR CONGRESSMAN DURHAM: This is in response to your January 18, 1957 letter concerning the activities of the Joint Committee on Atomic Energy. I should like to take this opportunity to review some of the interests of the Spencer Chemical Co. with regard to the atomic-energy program and our activities concerning this which are interrelated with our views on the suggested topics for discussion by the committee.

The Spencer Chemical Co. has an access permit with the Atomic Energy Commission and has, as an adjunct to this, permission to review 15 categories of secret information. We have, as our prime interest, performing a service to the nuclear-fuel cycle, the development of high-temperature materials of construction, and the use of nuclear reactors and/or irradiation in the process industries. We have 25 "Q" cleared personnel in our employ and maintain a secured area wherein we can review classified material and perform engineering studies. Some of our engineers have had experience in chemical processing of nuclear fuels, and in studies on industrial utilization of atomic energy, prior to their present assignment.

As a part of our pilot-plant program we have installed equipment to study fuel-processing phases and have obtained a license from the Commission to conduct certain work. All of this activity is privately financed and is aimed at finding phases of the overall nuclear program wherein we might perform a service.

The need for scientists trained in the field of nuclear technology has been emphasized by various authorities. We believe that some help in this regard might be acquired through greater industrial participation in the various phases of atomic energy utilization. We believe that one way to acquire know-how and accomplish technical advance is through participation.

For example, the chemical industry has a relatively high technical skill in the general field of thermodynamics, reaction kinetics, heat transport, heat flow, etc. We understand these principles to be similar to those encountered in nuclear technology. We believe that there are programs within the Atomic Energy Commission which can be handled successfully by the relatively unschooled, compared to nuclear physicists, and that through such participation, skills will multiply.

We have in mind a possible study in which a survey of the chemical industry would be made with a view toward determining possible locations for nuclear reactors in the process industries. Such locations would be other than for the generation of electrical power.

We believe that the Commission, in keeping with the Strauss program, should sponsor such activities with the twofold purpose of training technical manpower and of gaining greater assistance in the utilization of atomic energy.

We have been considering for some time the reprocessing of nuclear fuels

and, as stated, have installed facilities in our pilot plant to conduct tests in this regard. As a result of our review and investigation of this, we have concluded that in order to establish within the near future a private interest in the nuclear fuel processing field, assistance would be needed from the Commission. Such assistance, we propose, might be in the form of making available to private industry nuclear fuels to be processed, this processing being done on a competitive basis. Specifically, we believe scrap generated in the fabrication of fuel elements would make a good starting basis and we have made a preliminary proposal to the Commission along this lines.

We are concerned with activity on the waste-disposal problem. We are especially interested in this since we represent a potential fuel processor and since it appears that the burden of waste disposal will exist at this point. Of interest to us in this field are the following:

1. Improved methods of handling waste at reduced cost.
2. Greater insight into the tolerance level of exhausted streams from processing systems.

Pricing policy appears to be centered around placing a fuel value on nuclear material. We favor a more realistic pricing schedule so that the system is free of subsidies.

We recognize the need for maintaining a strong security system, but we favor maintaining a degree of classification commensurate with the international level of technology. By definition, security hinders flow of information, which is incompatible with the maximum rate of technology advanced. We believe the Commission has performed an admirable task of making available information to industry. We favor more progress in this direction.

With regard to the international market for reactors and components, we generally favor competitive advance of American Industry into areas which will offer stimulus to our national economy and to raising the international scale of living. The building of reactors abroad would appear to be in keeping with this.

Thank you for the opportunity of presenting our views. We have read with interest many of the documents covering hearings held by the Joint Committee and want to commend you on the energy and wisdom which has gone into this activity.

Sincerely yours,

KENNETH SPENCER, *President.*

MIDDLE SOUTH UTILITIES, INC.,
New York, N. Y., February 20, 1957.

Hon. CARL T. DURHAM,
Chairman, Joint Committee on Atomic Energy,
Congress of the United States, Washington, D. C.

DEAR MR. DURHAM: The activities of Arkansas Power & Light Co., Louisiana Power & Light Co., Mississippi Power & Light Co., and New Orleans Public Service, Inc., the four operating companies comprising the Middle South Utilities system, may be of interest to the Joint Committee in connection with its consideration of the development, growth and state of the atomic-energy industry in the hearings currently being held under section 202 of the Atomic Energy Act of 1954.

In December 1956 the Atomic Energy Commission was advised that the Middle South system companies had initiated investigations for the purpose of determining the feasibility of constructing a prototype nuclear power reactor in the Middle South. The companies asked several equipment manufacturers and other organizations active in the atomic field to identify to them a conceptual design of a power reactor which, in their opinion, would contribute importantly to the advancement of reactor technology if built in prototype size. In addition, the companies asked that the reactor designs so identified be those considered by the proposers to hold promise, if later constructed in larger size, of ultimately providing an economically feasible source of energy to supplement conventional fuels in the Middle South system service area.

Since reporting to the AEC in December, the Middle South system companies have received five proposals for the design and construction of power reactors in prototype size of from 15,000 to 30,000 kilowatts electrical capacity. They are now in process of analyzing and appraising in detail those proposals. This study will not be completed in time to report thereon during the 1957 section 202 hearings.

The Joint Committee might be interested in knowing that among the reactor designs submitted are two reactors which would use heavy water as the moderator and which either would be fueled with natural uranium or would be prototypes for larger reactors that would use natural uranium. Proposals also were received for designs that would utilize graphite or beryllium as the moderator and a liquid-metal coolant.

Certain other electric utility companies in the general section of the country in which the Middle South system companies serve have expressed an interest in discussing with us the possibility of participating in a prototype reactor project. This matter also is being studied.

Trusting that this information will be of interest to the Joint Committee, I am,

Respectfully yours,

E. H. DIXON, *President.*

STATEMENT BY WILLIS GALE, CHAIRMAN, COMMONWEALTH EDISON CO.

DESCRIPTION OF THE DRESDEN PROJECT

The Commonwealth Edison Nuclear Power Group project was initiated through a proposal to the Atomic Energy Commission in March 1955. The plant, which will have a boiling water reactor, is to be called Dresden station and is the largest all-nuclear power-producing facility under way in this country. Its capacity will be 180,000 kilowatts. It will be located about 50 miles southwest of Chicago.

Commonwealth Edison Co. has a contract with General Electric Co. for the construction of Dresden station for $45 million. Bechtel Corp. is employed by General Electric as engineer-constructor. The plant is being financed entirely with private funds.

Commonwealth Edison will own and operate the plant and will pay $30 million toward the $45 million contract price. This $30 million, plus more than $5,500,000 of overhead and site costs, will be capitalized and included in Commonwealth Edison's utility plant.

The $15 million remainder of the contract cost is being paid as a research and development expense over a period of 5 years by 8 companies which are associated in Nuclear Power Group, Inc., namely:

American Gas and Electric Service Corp.
Bechtel Corp.
Central Illinois Light Co.
Commonwealth Edison Co.
Illinois Power Co.
Kansas City Power & Light Co.
Pacific Gas & Electric Co.
Union Electric Co.

CURRENT STATUS OF THE DRESDEN PROJECT

The contract with General Electric Co. calls for monthly payments of $750,000 each in the years 1956 through 1960. There will be 60 of these monthly payments totaling $45 million. These consist of the $500,000 monthly payment which Commonwealth Edison makes toward its $30 million share and the $250,000 monthly payments through Nuclear Power Group, Inc., toward the $15 million of research contributions. General Electric has been paid $10,500,000 so far. By the end of 1957, payments will have totaled $18 million.

The contract requires completion of the project on or before December 8, 1960. The deadline set by the Atomic Energy Commission for the initial fueling of the reactor is September 30, 1960. We are informed by General Electric that its present schedule calls for trial operation of the completed plant by July 1, 1960.

General Electric, in turn, has made substantial expenditures on the project and has incurred large commitments. Since all phases of the actual design and construction of the plant are under its jurisdiction, I shall leave it for that company to furnish the committee full details of what has been done up to now and what is scheduled.

The significant fact is that every effort is being made to complete the project at the earliest possible time.

NEED FOR FEDERAL INDEMNITY LEGISLATION

The Honorable Carl T. Durham's letter inviting me to make this statement calls attention to the fact that separate hearings will be held on the proposed program of governmental indemnity against reactor hazards and on proposals for accelerating the nuclear power program. I shall not go into these subjects in any detail, but I do desire to stress the importance of early action on the indemnity bill.

We know of only one hurdle which could interfere with our project. That is the matter of third-party liability.

The insurance industry appears to be making good progress in developing a satisfactory program for the coverage of ordinary third-party-liability risks.

We consider the early solution of the problem of the catastrophe risk to be of vital importance not only to our own project but also to the progress of the country's atomic program, to the public at large, and to the builders and owners of all reactors.

The joint committee indemnity bill (S. 715 introduced by Senator Anderson and H. R. 1981 introduced by Mr. Price) appears to us to represent a practical solution to the indemnity problem. We urge favorable consideration at the earliest possible date.

Last year I told the committee that we are unwilling to say that we will abandon our project if the indemnity legislation is not passed. Rather, we have hoped that the committee would be convinced of the importance of the problem and the need for early action. I stated that we were going ahead full speed on our project with confidence that the Congress would act promptly and favorably on the indemnity bill. This continues to be our policy.

FUEL FABRICATION AND REPROCESSING

One of the greatest difficulties along the road to competitive nuclear power is the present uncertainty in the various phases of the fuel problem.

The availability of suitable materials for cladding, like zirconium, at a moderate price is of the utmost importance. So is the cost of fabricating fuel elements. At the present time, it appears that prices for suitable materials and also for the fabricating of these materials will be high. No doubt prices will decline if a good volume of business develops in this field.

Another area of great uncertainty is that of reprocessing spent fuel elements.

At the present time, those who plan to build nuclear reactors are not informed as to the AEC policy on the disposition of fuel elements. We understand that the Commission has this matter under consideration and, in fact, may have announced its conclusion after this statement was written.

We are confident that a sound policy will be worked out in due course and are proceeding on that assumption. However, it would be helpful in our planning, especially in fuel-development work, if we could know at an early date what is to happen to spent fuel.

Under today's requirements, the reactor owner must pay rent to the AEC on fuel while it is being shipped to a fuel element fabricator. The rental will continue while the fuel is in the reactor but from then on there are many questions, for example:

When will the rent stop?
Will the AEC chemically separate it?
If not, who will?
What will be the charges for separation?
Who will own the fission byproducts?

FUEL COST DURING EARLY YEARS OF OPERATION

A problem related to fuel fabrication and reprocessing is that of the probable extraordinarily high fuel cost of electricity generated during the first few years of operation of a power reactor.

In the case of a conventional facility, the fuel cost is the delivered cost of coal, oil, or gas. In the case of an atomic facility, however, there is not only the Commission's charges for nuclear fuel but also the cost of cladding materials, the cost of fabrication of fuel elements, and the cost of the chemical separation of spent elements. A further vital difference is the trial and error necessary to the achievement of a satisfactorily long burn-up period.

It appears that the realization of the ultimate fuel cost based on maximum efficiency will not be accomplished for a period of 5 to 6 years after start-up.

During this trial and error period, the reactor owner is likely to incur very substantial excess costs. These extra costs could serve as a serious deterrent to the undertaking of otherwise worthwhile projects.

The Commission has stated that it is aware of the problem and that it may do something about it. This could be accomplished through reduced charges for nuclear fuel during the early years of a reactor's operation.

I believe that it would be extremely helpful in the acceleration of the reactor program, if some action of this kind were to be taken.

NUCLEAR POWER GROUP ATOMIC RESEARCH

The eight companies participating in the research cost of the Dresden project also conduct a combined atomic power research project under the name of Nuclear Power Group. This study group undertakes to keep abreast of all important developments in the field of atomic power. The group's special interest is to consider the merits of and prospects for all of the promising power-reactor types. It also makes more detailed studies of those types which appear to be most promising for early construction.

It was a detailed research study made in cooperation with General Electric Co. that led to our decision to go forward with the Dresden boiling water project.

The study group has recently completed in cooperation with Babcock & Wilcox a detailed study of the homogenous reactor.

At this point, I wish to comment briefly on some principal types of reactors now under consideration in the United States. Our views are largely the result of work done by Nuclear Power Group. However, our conclusions at Commonwealth Edison are our own and may or may not be concurred in by representatives of other companies in our group.

THE GAS-COOLED GRAPHITE-MODERATED REACTOR

One study by Commonwealth Edison before the formation of Nucler Power Group covered the gas-cooled graphite-moderated reactor, the type adopted by the British. Gas is not inherently a good heat transfer agent and our conclusions were not favorable, largely because of the cost of pumping huge volumes of gas for cooling. I am told that the British choice was based in part on improved design but more importantly on the fact that the gas-cooled graphite-moderated reactor can be fueled by natural uranium without enrichment. The British do not have large-scale faciilties for the separation of U–235 from natural uranium.

Nuclear Power Group has reviewed an up-to-date study by Babcock & Wilcox of the gas-cooled type of reactor. This indicates the possibility of greatly improved economics through the suspension of graphite dust in the gas; also through the use of unclad ceramic fuel elements.

These developments have not progressed to the point of indicating that serious consideration should be given at this time to the actual building of a full-scale facility. They do point to the desirability of further study which is being carried out by Nuclear Power Group and others.

THE PRESSURIZED WATER REACTOR

The pressurized water reactor has been a favorite in the United States. It has been demonstrated beyond any doubt that a pressurized water reactor can be built and operated very satisfactorily. It is our view, from the standpoint of economics, that this type of reactor is much superior to the gas-cooled graphite-moderated in its present stage of development. However, costs must be substantially reduced before the pressurized water reactor becomes competitive in the United States. Its prospects would improve if heavy water were to become sufficiently inexpensive to eliminate the need for fuel enrichment. The pressurized heavy water reactor would be especially attractive in foreign countries where U–235 for enrichment is not available.

THE BOILING WATER REACTOR

We adopted the Argonne Laboratory boiling water reactor principle because our studies indicated considerable superiority, from the point of view of economics, over any other type ready for early construction. We believe that the benefits such as higher steam pressures and savings in heat-exchanger costs will more than offset the effects of using radioactive steam in the turbine.

In our opinion, the boiling water reactor has great promise. Whether this promise is realized will depend to a considerable extent upon the experience of Commonwealth Edison Co., its partners in nuclear power group, and General Electric Co. in building Dresden Station and of Northern States Power Co., its associated companies, and Allis-Chalmers with their recently announced project.

A next step forward for the boiling water reactor would be the use of heavy water. Here again, the cost of heavy water is the important consideration. The boiling heavy water reactor faces more problems than the pressurized heavy water reactor but it should be given careful consideration. Argonne Laboratory already has scheduled the first test of heavy water in its boiling reactor.

THE HOMOGENEOUS REACTOR

Our preliminary studies have indicated that the homogeneous reactor has considerable promise through elimination of the cost of fabricating fuel elements and dissolving them for chemical processing. On the other hand, there are serious corrosion and maintenance problems in the handling of the radioactive solution. There is also the investment cost of the necessary chemical separation plant. In our opinion, the homogeneous type has great ultimate promise but we question if it is ready to be built today on a full-scale basis.

LIQUID METAL REACTORS

There is increasing interest in liquid metal reactors of various types. Liquid sodium, for example, is one of the best heat-transfer agents.

If the metallurgical problems involved in handling liquid metals can be solved economically, this type offers great future promise. This promise may be realized through reactors of the thermal type or the fast breeder type, or both.

CONCLUSION

One of the most favorable aspects is the indication that manufacturers like General Electric, Westinghouse, Babcock & Wilcox, North American Aviation, Allis-Chalmers, and others are making substantial progress toward the goal of being able to present to a utility, whether publicly or privately owned, proposals for the building of a practical nuclear power facility. When that goal is achieved, the utility can select from the presentations by different manufacturers a type which appears to suit its conditions. This is what has made America great in other fields.

If greater speed is of the essence, there remain serious problems which can be solved only through partnership between the Federal Government and existing utilities.

One of the most urgent of these is the need for Federal indemnity against excess third-party liability. As I have said, it would be of tremendous help to have the committee bill passed by the Congress at an early date.

There is the further problem which arises from the need for assistance in the building of large-scale reactors. This need, in our opinion, should be satisfied by an expansion and modification of the demonstration reactor program.

A full-fledged competitive nuclear power industry is not just around the corner in the United States or elsewhere. However, the outlook for the long-range future is very encouraging.

GENERAL ELECTRIC CO.,
ATOMIC PRODUCTS DIVISION,
Schenectady, N. Y., February 20, 1957.

Hon. CARL T. DURHAM,
Chairman, Joint Committee on Atomic Energy,
Congress of the United States, Washington, D. C.

DEAR MR. DURHAM: As I mentioned in my letter of February 6, I am deeply interested in the acceleration program and the problem of insurance and liability protection and hope to appear before you at the time of hearings on these matters.

At this time I believe that the following items are of concern to many, and they are worthy of being called to your attention.

Economic situation

Of primary importance is the present lack of economic incenitve. Normally a business begins to grow rapidly when its products produce increased value for

its customers. Presently there is much to do before atomic power is competitive in our normal markets; hence, our customers are spending money on their projects rather than receiving increased value from them. I believe that it takes more than the usual faith and courage to invest heavily in such a business environment.

Your hearings will be of value in informing the public that:

1. Atomic electric power will not be cheapest in this country for some indeterminate years to come.

Atomic electric power is needed in the world, but only where and when it is proven to be less expensive than other means. I have no doubt that nuclear power will be economic and that the amount of time and effort put into it will to some extent determine the date. However, we do not have accurate costs on our major project and will not until after it is completed and operating. I believe others are in the same situation. All that I hear and observe, however, indicates that capital costs on all designs must be greatly reduced before true economics can be demonstrated.

2. The reasons for the preoccupation of many other countries are due to their dissimilar economic or political circumstances.

As I view it, the economic and public policy considerations abroad are quite different from ours; hence, different rates and directions of technological effort are inherent in their programs. For example, Britain and Europe generally appear driven by both the high cost of fuel and the urgency of being independent of long transportation lines and other important problems.

Indemnity legislation

I note that you intend to cover indemnity legislation separately, but cannot refrain from again urging that the Congress make its position clear on this at the earliest possible moment.

As you know, I testified strongly in favor of the Anderson-Price bill introduced in the Congress last year. We believe that this bill recognized the unique problems in this developmental phase, and its passage will remove a major roadblock to progress.

Turning to the points mentioned in your January 18 letter, I have the following comments:

Status of present projects

The large plant at Dresden is now passing rapidly from the design and procurement stage to the construction phase.

In more detail the status is as follows:

The scoping or schematic design is complete. This phase comprised a major portion of the scientific and conceptual engineering effort.

Detailed design is 33 percent complete and progressing rapidly. This phase comprises the translation of the scoping work into drawings and specifications to which the constructor can work.

Fifty-five percent of the total material has been ordered including most major components and all known to be limiting. Specifically,

(1) the turbine generator
(2) the reactor vessel
(3) the containing sphere
(4) the steam drum and secondary steam generators
(5) the condenser

are all on order with, in addition, about $4 million of smaller items.

The Dresden site was cleared last year so that major construction could start as soon this year as the weather becomes favorable. The whole job is on schedule and we expect to meet the dates provided in our contract and construction permit.

Construction of our major laboratory for proof testing and core development described to you last year is well along, and on schedule. The boiling water reactor prototype is on schedule and going into final assembly of major items at the site. Fuel fabrication for the critical assembly is progressing rapidly and the cell is now complete. Nonnuclear developmental facilities in San Jose have been in operation for some time.

Reactor types other than for electric power

Assuming that the question in your January 18 letter was directed toward nonmilitary applications, I do not know of significant problems in this area. Research, test, and special-purpose reactors are being produced and in general are providing added values to the customer. Applications for large reactors are be-

ing studied, but in general I believe that their economics will become favorable after those for electric power and are essentially tied in with the same problems.

Fuel reprocessing

This is a present problem. As I see it, there will not be a steady load of fuel from industrial reactors for some time to come—yet without reprocessing costs and assurances the true economic costs of reactors are really unknown. I am hopeful that much work which I know that the Commission has been doing will lead to a definite announcement at the earliest possible time.

Waste disposal is a corollary of reprocessing, but I do not believe that special immediate action is needed here. I feel that solutions and practices developed for the Commission's production program have laid an adequate groundwork.

Prices

We are pleased that the price schedule has been released. While it is true that any price schedule arbitrarily affects development of promising reactor types, I believe that the Commission has taken the right step in fixing prices at this time and thus clearing the path for work to go forward.

Declassification

I am heartened by assurances of forthcoming declassification under the Tripartite Guide intended to free information on civilian reactors. At this writing our organization has not had time to appraise how closely this has been accomplished so that I cannot comment further.

International market

Finally, the international market has become clearer over the past year but there is still much to do. Liability problems are appearing in many forms. An exploration of solutions to these problems is urgently needed. True economics are still dependent on governmental arrangements for fuel and reprocessing. There appears to be a definite question whether reactors using enriched U–235 will be preferred, or whether many countries will wish to follow a path of natural uranium technology or of a self-sustaining plutonium or thorium cycle. These latter techniques are at a much earlier stage of development than those continuously dependent upon a small amount of U–235. Recent events have led me to hope that by next year a clear pattern will have emerged and that I will be able to discuss in more concrete form problems and accomplishments in this area.

Sincerely,

F. K. McCUNE,
Vice President and General Manager.

YANKEE ATOMIC ELECTRIC CO.,
Boston, Mass., February 20, 1957.

Hon. CARL T. DURHAM,
Chairman, Joint Committee on Atomic Energy,
Washington, D. C.

DEAR MR. DURHAM: In response to your invitation, I should like to submit the following statement to be included as a part of the record of the Joint Committee's 1957 hearings under section 202 of the Atomic Energy Act. I believe the committee will be interested in a current report on the nuclear-power project being carried out by Yankee Atomic Electric Co. In addition, I should like to comment briefly on certain of the topics suggested in your letter of invitation.

Proposed demonstration powerplant of Yankee Atomic Electric Co.

During the past year Yankee has pressed forward with its plans to construct and operate a 134-megawatt nuclear powerplant in western Massachusetts.

The original concept and development of this project were outlined at the time of the 1955 and 1956 hearings. Briefly summarized, Yankee was incorporated as a Massachusetts electric-utility company in September 1954. Its stockholders are 12 of the major New England utilities, who will purchase the entire power output of the Yankee plant. The nuclear portion of the plant will consist of a pressurized water reactor, using an initial core of slightly enriched uranium oxide contained in stainless-steel tubing.

Yankee's proposal under the first round of the power demonstration reactor program was accepted by the Commission on February 8, 1956, as a satisfactory

basis for further negotiations. On June 4, 1956, a formal contract with the Commission was executed which provides, among other things, for assistance in the research and development phases of the project up to a total of $5 million and for a waiver of use charges for special nuclear material for a term ending 5 years after issuance of a license to operate the reactor. Commission assistance in the research and development program will provide $4 million to reimburse Yankee for expenditures in private facilities and $1 million to defray costs of work to be performed in Commission facilities.

Upon execution of the basic contract with the Commission, Yankee contracted with Westinghouse Electric Corp. to carry out the research and development program to be performed in private facilities and to assist in scheduling and evaluating the work to be performed in Commission facilities. This subcontract was approved by the Commission and executed on September 4, 1956.

Work on the research and development program was already in progress in advance of formal execution of the subcontract with Westinghouse, and has since gone forward at an accelerated pace with the full cooperations and assistance of the Commission's Schenectady operations office, which is responsible for the administration of the Yankee contract. In addition, preliminary engineering work on the design of the plan and auxiliary systems has progressed along with work on the research and development phase of the project. This work has been carried out principally by Westinghouse and Stone & Webster Engineering Corp., with whom Yankee is negotiating a contract for the actual construction of the plant.

As a result of the work to date, the conceptual design of the plant has been firmed up, most of the important components of the plant have been sized, and detailed design work has commenced. The principal efforts of our program at this stage are focused on completing design and engineering work to the point where a fully detailed cost estimate can be prepared by late spring or early summer when construction is scheduled to get underway. Meanwhile, an interim estimate has been made which indicates that overall costs of the plant will exceed the original estimate of approximately $35 million by a substantial margin. This increase has resulted in part from escalating costs generally, and in part from design and engineering requirements disclosed as the work has progressed.

The increased costs indicated by this interim estimate indicate eventual power costs in the range of 12 to 14 mills per kilowatt-hour, as compared with earlier estimates in the range of 10 to 12 mills per kilowatt-hour. While power costs of this order are not wholly unexpected for an early demonstration reactor, they do indicate the need for a full and careful reexamination of the project to be certain that nothing has been overlooked which might result in power costs more nearly competitive with those of conventional generating facilities. We are continuing our efforts in this direction with the full cooperation of Westinghouse and Stone & Webster in the hope that some savings may be reflected in the definitive estimate of costs due a few months hence.

Yankee's license application was filed with the Commission in preliminary form in July 1956. An amendment is now substantially completed, which will provide the Commission with the detailed technical information and preliminary hazards summary necessary to support the issuance of a preliminary construction permit Construction at the site is presently scheduled to commence in the summer of this year for completion late in 1960.

Expenses of the project to date have been met by the sale of stock to the 12 sponsoring companies, and regulatory approvals have been obtained for loans from these companies which will carry the project well into 1957. Conversations with commercial banks and institutional investors indicate that a suitable financing program can be arranged to meet major construction expenditures as the program progresses, and various alternative programs are now under consideration which will provide the necessary permanent financing. Final arrangements with respect to permanent financing cannot, of course, be made until the overall cost of the plant is more precisely known. Various alternatives are available to provide interim financing for the project if it appears that permanent financing can be more advantageously arranged after the plant has been completed and successful operation achieved.

Fuel fabrication and reprocessing

The increases in capital costs being experienced by Yankee and others who are undertaking the construction of first generation reactors reflects in part the rising trend in prices and costs generally. This affects the cost of nuclear plants and conventional powerplants alike and does not necessarily alter the basic com-

parison between them. In part, however, these increases in costs result from the hand-tailored nature of first generation reactors, each of which must be built as a custom job, using specially designed components. This aspect of costs holds the greatest promise of economies that may be realized in the future when component parts, if not entire reactors, can be standardized and produced more nearly on a volume basis. These economies, however, lie well in the future and will be realized only after the early reactors have been built and the present higher costs embedded.

In view of these higher capital costs, it becomes increasingly important to explore all possible avenues for reducing the expense of fuel to the first generation reactors, so as to bring overall power costs within reasonable range of the costs of conventional plants. Costs of fuel fabrication and reprocessing are factors of major importance in this area.

Ultimate economies are clearly possible when additional reactors are built and volume operations can be achieved. Fortunately, volume operations in these fields are not dependent solely upon power reactors, since an increasing volume of fuel fabrication and reprocessing is already in sight for reactors used for naval propulsion and other purposes. Meanwhile, however, both fuel fabrication and chemical processing will tend to be high-cost operations which cast an added burden on the first generation civilian reactors.

Accordingly, we believe the suggestion clearly warrants full examination that fuel fabrication costs and reprocessing costs to first generation reactors should be reduced through Government assistance, either directly by reduced charges at Commission facilities or indirectly by extending financial assistance or price guarantees to private fabrication and reprocessing facilities during the interim period before volume operations can be achieved.

Pricing policies

These same considerations make it appropriate to reexamine present pricing policies as a means of reducing fuel costs for the first generation of pioneering reactors, whose early construction is a matter of vital importance to the entire atomic energy program. Here, too, there are valid reasons for considering all possible means of reducing fuel costs during the early years of operation. Specific suggestions along this line would include a reduction or waiver of use charges for as much as the first 10 years of operation; extending beyond 7 years the period during which special nuclear material prices can be guaranteed under section 56; furnishing special nuclear material in the form needed for the particular reactor, thus eliminating the present substantial charge for converting uranium from hexafluoride to metal or oxide form; accepting the return of special nuclear material in the form of spent fuel elements, thus eliminating the present charge for chemical reprocessing; or, as an alternative to the last two suggestions, pricing the charges for converting from hexafluoride and for chemical reprocessing in Commission facilities on an out-of-pocket basis rather than on the present full-cost recovery basis.

Test reactors

The present period in reactor technology is in many respects a critical one during which experimental results with many different reactor prototypes are being extrapolated to large sizes suitable for use in industry and defense. An essential step in this process is the testing of reactor materials in a high neutron flux test reactor. The present difficulty of obtaining space and in-pile radiation time in the materials testing reactor and engineering test reactor is already critical, and the rapidly increasing needs for such facilities will not be wholly met by the additional test reactors currently under construction by the Commission and certain major industrial concerns. It appears that this is an area where limited expenditures may well achieve very significant results in removing a little publicized bottleneck in the overall national program.

Questions to be considered in later hearings

We note that the proposed program of governmental indemnity against reactor hazards and proposals for accelerating the nuclear power program will be the subject of more detailed discussions in later hearings.

As we have indicated in prior statements to the Joint Committee, we feel that the insurance and indemnity problem is of major importance. Yankee has gone forward with its program to date in the confidence that suitable protection at an acceptable level of costs will be afforded by a combination of private insurance and governmental indemnity.

In connection with proposals to accelerate the nuclear power program, we note with interest the Commission's recent announcement broadening the scope of the power demonstration reactor program. We believe that further stimulus to the nuclear power program would be provided by incorporating the suggestions made above with respect to fuel fabrication and reprocessing and with respect to pricing policies.

Yours very truly,

WILLIAM WEBSTER, *President.*

CONSUMERS PUBLIC POWER DISTRICT,
Columbus, Nebr., February 21, 1957.

HON. CARL T. DURHAM,
Chairman, Joint Committee on Atomic Energy,
The Capitol, Washington, D. C.

DEAR MR. DURHAM: I appreciate the invitation to appear at the hearings before the Joint Atomic Energy Committee to be held in accordance with the Atomic Energy Act of 1954; however, previous plans make my appearance impossible, so I am filing this written statement in accordance with your letter of February 6, 1957.

My principal interest in the atomic energy field lies in the economical production of electricity from nuclear energy, as the Consumers Public Power District, of which I am general manager, has engaged in intensive studies in this field over the past several years. Our negotiations with the Atomic Energy Commission for the construction of a 75,000-kilowatt atomic plant are now in their final stages, and we anticipate that the formal contracts will be signed in the near future.

The basic problems, in developing an aggressive yet sound program, for the economical production of electric power from nuclear energy revolve around two major difficulties, namely, high construction costs over those for conventional facilities, and unknown operating conditions and costs. Construction costs of all kinds are generally on the increase and must be dealt with on any type of project; however, it is the difference in cost between electric power from nuclear facilities as compared to that from conventional facilities that concerns the reactor development program. It is a condition of the times which must be recognized and accepted if the program is to continue moving forward.

Electric utilities, whether private or public, have an obligation to render service to their customers as economically as possible, consistent with sound business principles, which includes reasonable development and experimental programs offering encouragement for more efficient or less costly electric service in the future; however, the utility responsibility does not include excessive risks or gambles which might seriously affect the cost of electric service to the customers. Therefore, such utilities as enter into the atomic-power-development program must, of necessity, seek means of minimizing the risks involved by one means or another.

If rapid development of nuclear power is to proceed, much of the risk in both construction cost and operating cost, above that for conventional facilities, will ultimately fall on the Government, either directly or indirectly. I urge that these increased costs not be allowed to nullify the national and international objectives of the reactor-development program and leave the United States and its electric utility and atomic industries in a secondary position to those of other countries.

I also suggest the activation of an advisory committee to the Atomic Energy Commission similar to the previous Utilities Advisory Committee, which should be invaluable to the Atomic Energy Commission and its staff in the formation and review of procedures and policies affecting the development of economic nuclear power.

Very truly yours,

R. L. SCHACHT, *General Manager.*

WILSON & EARL,
Manchester, Conn., Feb. 14, 1957.

Representative CARL T. DURHAM,
Chairman Joint Committee on Atomic Energy,
The Capitol, Washington, D. C.

DEAR REPRESENTATIVE DURHAM: As you know from previous correspondence, and the agenda for the establishment of the Institute for Nuclear Serology which we have furnished the committee and certain other Members of the Con-

gress, as well as the concerned activities of the executive branch, we believe that it has become imperative, that a well-planned and programed coordinated effort be made, to teach and train a substantial number of medical technicians, in the public health aspects of the civilian applications of atomic energy, particularly as it may relate to standards for protection against radiation hazards, as more fully established by the recently issued regulations of the Atomic Energy Commission (10 CFR pt. 20) Code of Federal Regulations.

After having made a somewhat thorough investigation of this matter and, having had the benefit of some very plain talks with substantial members of the community who are interested in the peaceful applications of atomic energy, we are convinced that this country must face up to the problem of dealing with radiation induced neoplastic diseases, including cancer. We believe that it is necessary to mobilize the necessary manpower (brains), materials, money, and management to accomplish the solution of this problem, even though it may take the entire coordinated resources of the United States Government.

We do not believe that the magnitude of the hazards to the health and welfare of workers in the atomic energy industry, and the public are particularly well understood. In ignorance, the people stand in fear. There is a heavy responsibility on the part of the committee as assigned by the Congress, to see that problems of this kind are taken care of with reasonable dispatch, and precise management and administration—as we interpret section 202 of the Atomic Energy Act of 1954.

It is our view, which we previously expressed, when we appeared before the committee last year, and with which view you personally agreed, that what we need in terms of education for atomics, is an expanded program for the training of technicians for atomics.

The unreasonable fear which has accompanied the peaceful development of the atom, must give way to intelligent reasoned knowledge. It will not if that knowledge is reserved in ivory towers of government, science, and research—be that knowledge ever so erudite. The people of America must share that knowledge, and in the language and words they understand, so splendidly exemplified by the Walt Disney production titled "Our Friend the Atom," as written by Dr. Heinz Haber. This is good work.

When I appeared before you on February 16 of last year, I said that we as management consultants felt that the manpower problem could be met with a so-called technicians for atomics in-plant training program. We still feel so, and in the case of those segments of American industry which are actively participating in the civilian applications program, we are assured that this sort of thing is being undertaken.

However, for that segment of the American complex, who are competent to assist, and who have little or no knowledge other than that which is of a wholly misleading popular conception, there is still no adequate training program for training technicians for atomics, within the meaning as used by the British and Russians. Why?

Further if we are ever to gear up our local governments and State governmental structures in as vital a measure as the regulations in connection with hazards, and we expect American industry to produce necessary radiation protective equipment and instrumentation, to give force and effect to this radiation hazards regulation, just where does the public health official, in State and local governments, send his inspection and administrative staffs, at a reasonable cost in terms of both time and money, so that they will have a reasonable grasp of this problem? Or for that matter where would the committee suggest that local labor leaders go? My inference is plain I think—the reference is to the PRDC case.

Finally, gentlemen, you have before you, the matter of an indemnification program, the rates for which at this time, are largely a matter of blue-sky limits—the reference is to Senate No. 52, and House No. 888 the Anderson-Price bill.

It is pertinent to inquire as to why this is so. We suggest that since we do not, with any degree of certainty, know what radiation in its several forms does to the human body, perhaps it is prudent for that industry to undertake: (1) the syndicate operations they propose; (2) the reinsurance arrangements they have entered into ; and (3) the indemnification bill they sponsor. All of which to us is rather meaningless, unless we have accompanying it, a well-thought-out and planned program for conveying the intelligence and understanding needed by insurance inspectors, and salesmen and claim adjusters, as a very practical important manpower category, of technically trained and deeply concerned people.

To stop on the spot, the flood of nuisance and fraudulent indemnity claims which are bound to arise under the present circumstances, the committee should concern itself with the provisions for adequate control methods, particularly as those controls may relate to medical technology, and better techniques for the differentiation of radiation induced neoplastic diseases, and those of natural incidence. There are only a few claims now, and we are sure the Commission is quite familiar with most of them. Even these few have established the pattern of legal suit and complaint.

We hold of course that the answer is a vigorous well-planned and programed technical educational program at the local level. Since the towns of Hartford, Windsor, Middletown, and Groton, Conn., are now faced with management and administrative governmental decisions in this regard, that is education in connection with the hazards of atomic radiation, and atomic energy hazard control in the public interest, the thoughts of the ad hoc committee for the establishment of the Institute for Nuclear Serology, of which I am the Chairman, may make sense, in terms of the Atomic Energy Act of 1954, and the responsibilities of this committee of the Congress.

Once again you are faced with a decision of public versus private responsibilities. We have been urged that this is clearly a responsibility of the Atomic Energy Commission and that what we are suggesting is a preemption of that Commission's responsibilities. We do not think so in view of the quite specific provisions of the Atomic Energy Act of 1954 which deprives the Commission of the governmental monopoly it has held in this field. Rather we think it is a responsibility of the public utility industry, insurance, and manufacturing industries engaged in atomic-energy activities, and in the areas in which those activities take place.

So as to give practical effect to what we are suggesting, we would be pleased to conclude this letter with the thought that the only organization in the country and Government at the present time who has the capacity and operating knowledge to undertake an adequate pilot program for training "technicians" is the United States Navy at Groton, Conn., where the Navy is now training personnel for the atomic Navy. We suggest that this program be expanded to include appropriate "selectees" from concerned agencies, of (1) the Federal Government, (2) the State of Connecticut, (3) the local governments of Hartford, Middletown, Windsor, and Groton * * * and such other Connecticut communities as might be interested * * * plus such insurance personnel as that industry might deem advisable * * * and as selected by the insurance study group * * * it being understood that the level of training would be the equivalent of the so-called technician level as now taught by the Navy.

As to the leadership of this effort, we would nominate exclusively only one man, Capt. J. Barton Hoag, of the United States Coast Guard Academy in Groton, who did such a splendid job as the Associate Director of the International School of Nuclear Engineering and Science at the Argonne National Laboratory, and who has just recently finished the splendid text, Nuclear Reactor Experiments, which we understand is now in press or is about to go to press.

As to materials, supplies, and equipment, there now appears to be an adequate supply in Groton, either at the submarine base or at the General Dynamics Corp. laboratory * * * and plant.

As to money, we suggest a 50–50 proposition between Government, that is, the Navy and AEC, and participating industry and the local and State governments concerned, and a cost basis for tuition and housing, the "selectees" to be paid their regular compensation while attending the instruction program.

Management of the program to be in the hands of the Bureau of Personnel and Bureau of Ships and Office of the Chief of Naval Operations of the Navy Department as assisted by the AEC, and General Dynamics Corp. General pattern of the education, after the fashion of the Industrial College of the Armed Forces, and with sufficient flexibility to develop the parameters, and a curriculum in this pilot program which may be used in other sections of this country and abroad.

Senator Styles Bridges has been kind enough to suggest that I submit these views directly and personally to you as the chairman of the Joint Committee on Atomic Energy for the information and consideration of your committee.

It would, of course, be the hope of the ad hoc Committee for the Establishment of the Institute for Nuclear Serology that a number of its staff might be "selectees" of this "Institute for Atomics" programs at Groton.

We appreciate this privilege of submitting our views in writing on this important matter, since it saves both our time and expense and that of the com-

mittee; however, if, later on, the committee would like to question us, in connection with some specific features of this suggestion or the investigation which we have conducted of radiation-induced-cancer problem and allied neoplastic diseases, or, any of the many ramifications that there appear to be in connection with the educational problems as related to atomics, and insurance, and the hazards problem, please feel free to call on us.

Trusting that this letter and these views will be helpful to the committee with a particular view to doing something about making some progress with the educational hazards, and insurance problems, we should be happy to have this letter inserted in the record of the section 202 hearings if you think that such insertion would be helpful and in good taste and appropriate.

Most respectfully,

ELLIOTT EARL,

Chairman, Ad Hoc Committee for Establishment of the Institute for Nuclear Serology.

The CHAIRMAN. We will stand in recess now until 10 o'clock tomorrow.

(Thereupon, at 4:45 p. m. Monday, February 25, 1957, the committee was recessed, to reconvene at 10 a. m., Tuesday, February 26, 1957.)

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